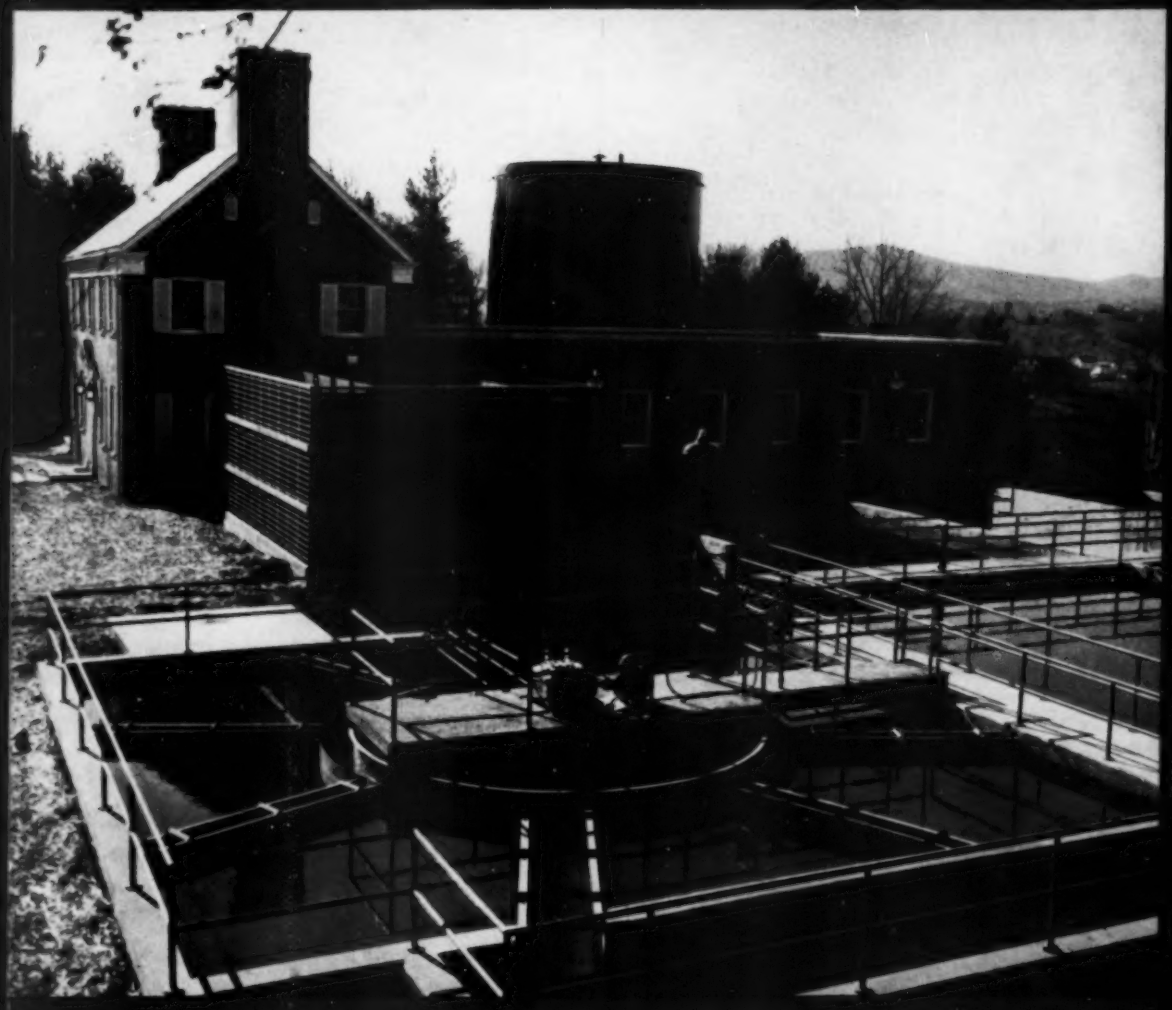
WATER & SEWAGE WORKS

WATER SUPPLY • INDUSTRIAL WASTE TREATMENT • SEWAGE DISPOSAL



MAY 1932

Pulsator's Novel Dual-Purpose Plant ...

LOCK JOINT

the ideal pressure pipe

for sewer force mains

Through the years Lock Joint has proven itself in water supply and transmission mains—and now more and more sanitary engineers are realizing its value for sewer force mains. It withstands high internal pressures and external loads, resists corrosion, tuberculation and rupture, has watertight flexible joints and will maintain a high carrying capacity for an estimated life of over 100 years.

Its performance is unexcelled, yet this high quality pipe is low in first cost and is virtually free from repair and maintenance charges. For top performance at rock bottom cost, specify Lock Joint Prestressed Concrete Cylinder Pipe for your next sewer force main project.

Lock Joint Prestressed Concrete Cylinder Pipe readily withstands the shocks of heavy city and highway traffic.

Its ability to withstand heavy backloads frequently makes it possible to lay Lock Joint Prestressed Concrete Cylinder Pipe in deep cuts without special bedding. The speed with which it may be laid and the fact that it can be immediately backfilled usually makes it unnecessary to sheet the trench.

SCOPE OF SERVICES—*Lock Joint Pipe Company specializes in the manufacture and installation of Reinforced Concrete Pressure Pipe for Water Supply Distribution Mains in a wide range of diameters as well as Concrete Pipes of all types for Sanitary Sewers, Storm Drains, Culverts and Subaqueous Lines.*

LOCK JOINT PIPE COMPANY

Est. 1905

P. O. Box 269, East Orange, N. J.

PRESSURE PIPE PLANTS: Wharton, N. J., Turner, Kan., Detroit, Mich., Columbia, S. C.

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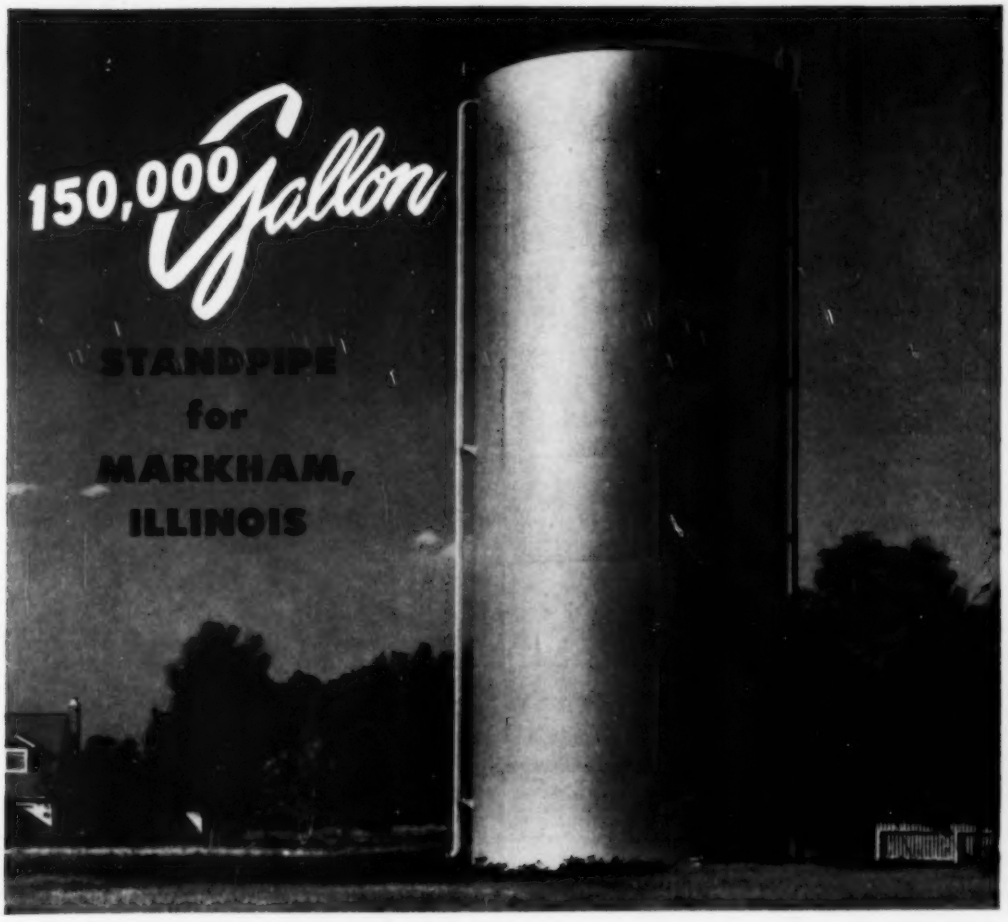

This 150,000-gallon Horton Standpipe is helping to keep more uniform pressures in the water distribution mains of Markham, Illinois. It serves the entire town, whose 2,748 population consumes about 125,000 gallons of water per day.

Here is how the Markham pumping and distribution system operates . . . low lift pumping equipment consists of two horizontally-split-casing centrifugal pumps which deliver 425 gpm. at 50 ft. head and 600 gpm. at 80 ft. head respectively. One centrifugal high-lift pump has a capacity of 300 gpm. at 30 ft. head. All pumps are automatically operated by electricity at an average cost of $35.00 to $40.00 per month. Water is purchased from the nearby town of Harvey, Illinois. When Harvey pressures are from 10 to 25 lbs. per sq. in. the small pumps at Markham cut in. Should the Harvey pressures be from 25 to 38 lbs. the large pump cuts in. Before the Horton standpipe was installed, minimum pressure in the Markham distribution system was 27 lbs.—now it is about 35 lbs. per sq. in.

Stand pipes are only one type of storage tank we build for municipal water supply systems. Others include Horton elevated tanks and Horton Waterspheres. For quotations and additional information, write our nearest office.

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WELDED STEEL
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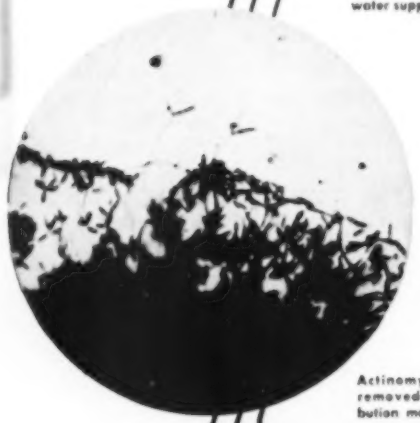
ARE YOU TROUBLED WITH ACTINOMYCETES?

Actinomycete colony removed from raw water supply. 5,000x.*

SYMPTOMS . . . Taste and odor complaints – particularly those classified as "earthy," "muddy," "musty" or "woody" – are, in many water supplies, attributable to actinomycetes, or ray fungi. Research conducted at North Texas State College shows that the by-products of the metabolism of these organisms impart an objectionable taste and odor to water at concentrations of approximately 0.2 ppm and higher. This research also establishes a satisfactory method of treatment.

TREATMENT . . . Chlorine dioxide is highly effective for the treatment of water supplies contaminated with actinomycetes. Proper application of chlorine dioxide at the treatment plant handles not only the vegetative colonies but can be valuable in controlling spores established in the distribution mains.

Chlorine dioxide is equally effective in removing tastes and odors due to phenols and algae, and for maintenance of residuals in the distribution system. For further information or for technical assistance on these and other water treating problems, write Mathieson Chemical Corporation, Baltimore 3, Md.



Actinomycete colony removed from distribution main. 2,000x.*

Mathieson CHEMICALS

*Photomicrographs courtesy of Dr. J.K.G. Silvey, North Texas State College.

9904

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INDUSTRIAL WASTE TREATMENT

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Published Monthly—subscriptions in the U.S., Canada and Latin America $2.00 per year; Foreign $3.00. Single copies 25c.
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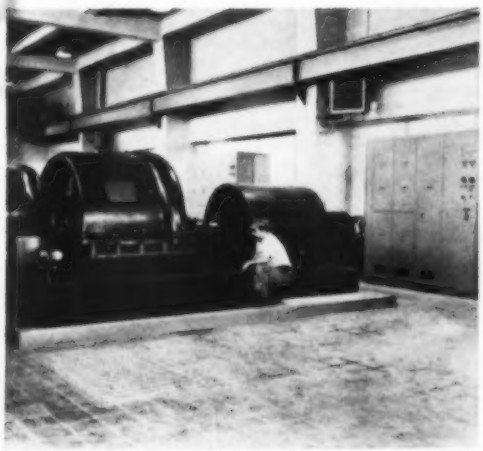
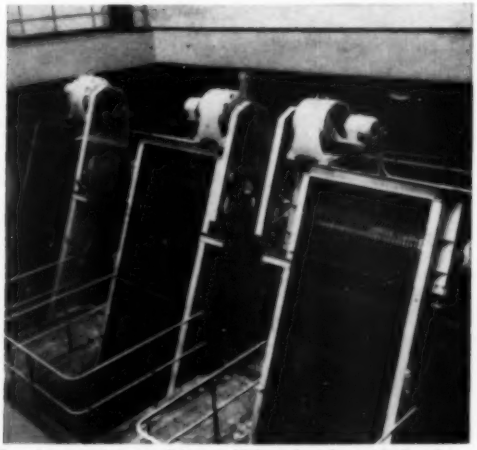
In main pump room, six G-E motors ranging from 450 to 700 hp drive centrifugal pumps. G-E control beside each motor provides speed and field control for wound-rotor and synchronous motors respectively. Plymouth Electric Construction Company served as electrical contractor for the new sewage treatment plant.

New York takes another step

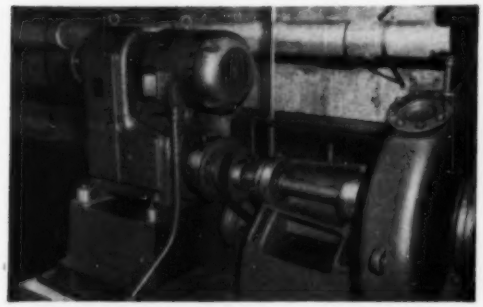


One of four G-E drives for aeration tank blowers is this 700-hp induction motor and secondary control. All large motors in plant operate at 4160 volts.



Tough operating conditions will be taken in stride by these three 3-hp G-E Tri-Clad totally enclosed motors driving bar screens through which influent first passes.

Settling tank collectors are powered by G-E Tri-Clad fan-cooled totally enclosed motors which resist corrosion by contaminated air. Small motors operate at 440 volts.



Tri-Clad* totally enclosed motor shown here is one of several driving pumps which move sludge from basins to digestion chambers. All such motors are centrally controlled.

*Reg. Trade-mark of General Electric Company

G-E switchgear provides primary control and protection for large motors and for transformers supplying 440-volt motors. Plant generates most of its power from sludge-digester gas.

in plan for CLEAN WATERS

G-E equipment plays a major role in new Owls Head Sewage Treatment Plant—8th major project in city pollution control program

This spring, Owls Head Sewage Treatment Plant—eighth major project in an over-all program to abate pollution of New York City's waterways—goes into operation. General Electric equipment, arranged in a co-ordinated system by city and G-E engineers to best meet operating needs, will provide a major part of the new plant's electrical system.

Capacity of Owls Head—160 mgd—is designed to serve the area's present population of one million plus an eventual increase of 20 percent. While it will immediately reduce pollution of lower New York Bay, the new plant's total effect will not be achieved until 1959 when all elements of the city-wide system will be in operation. Then, all waste entering sewers in metropolitan New York will be placed under treatment.

G-E equipment, backed by G-E application engineering assistance, proved valuable to New York in creating Owls Head. In the same way, General Electric, working with your consultants, can help with your sewage-plant electrical system. Call in your G-E representative ***early in the planning.*** And to gain public support for your new sewage facilities, ask him now how you can put G.E.'s CLEAN WATERS program to work in your community. ***General Electric Co., Schenectady 5, N. Y.*** 666-72

CO-ORDINATED SEWAGE-PLANT ELECTRIFICATION

GENERAL ELECTRIC

MIAMI IS LEARNING FROM EXPERIENCE

that only C-P-P* meets the BIG 3 REQUIREMENTS

On its new 10-mile water supply line Miami, Florida demanded *1. Long Life, 2. Sustained high carrying capacity, 3. Great structural strength. Only* in Concrete Pressure Pipe could they get *all three.*

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3. *High beam strength.* Price Prestressed Pipe makes your water line safe from external loads. It is shatterproof—and sudden and complete failure is all but impossible.

Here are four other reasons why Miami picked Price Pipe: *It's easy to lay*—can be installed quickly and easily because of its simple, self-centering joint. *It's easy to tap*—any service man does the job with regular equipment and a few accessories. *It's watertight*—the rubber and steel flexible joint adjusts to expansion, contraction, vibration and external loads without leaking. *It has great economy*—because of low original cost, low maintenance and extra-long trouble-free life.

Send for all the facts about Price Prestressed Pipe. Or call our engineers for specific answers to your questions. There will be no obligation.

* only CONCRETE PRESSURE PIPE has the BIG 3

- LONG LIFE
- SUSTAINED CAPACITY
- GREAT STRENGTH

PRICE-PIPE
PRESTRESSED CONCRETE
STEEL-CYLINDER PIPE

Price Brothers Company
1798 East Monument Avenue
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Please send me, without obligation, the following literature:

- ☐ New Water Supply Lines using Price Prestressed Pipe
- ☐ Complete facts on Prestressed Pipe

Name _____
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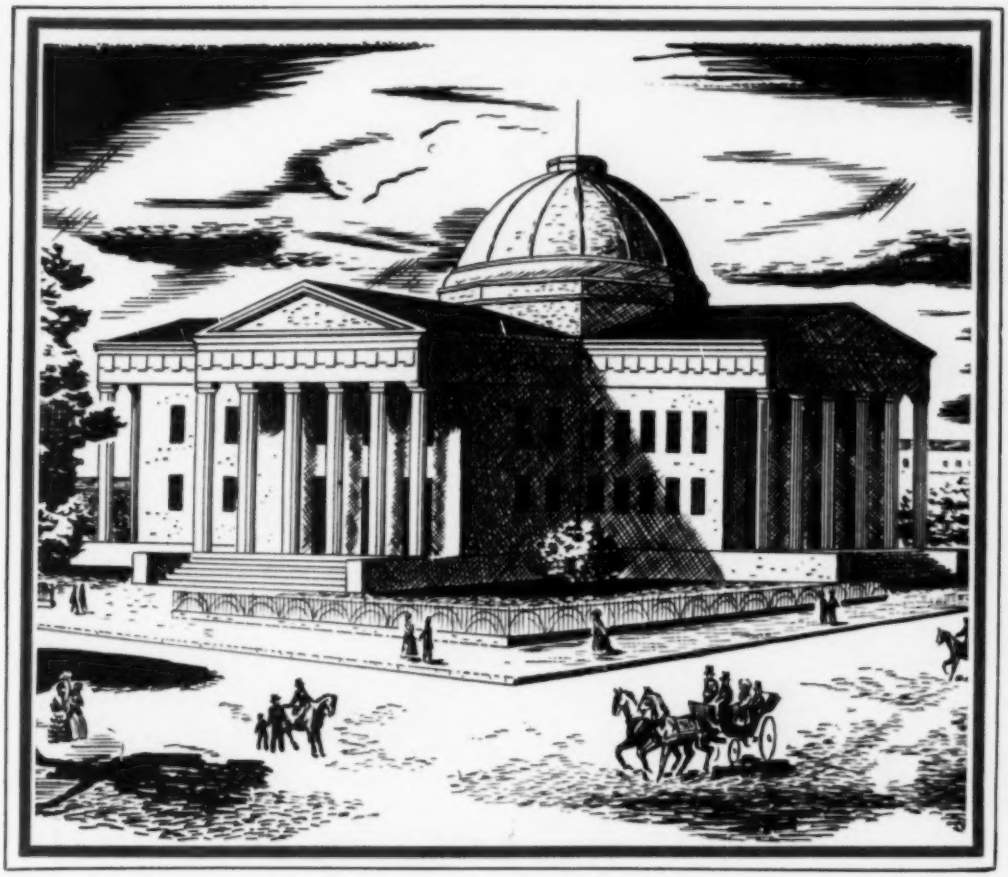

The old courthouse in St. Louis as it looked 100 years ago

St. Louis, Missouri has a cast iron water main in service that was installed more than 100 years ago. That is not surprising as St. Louis is one of our oldest cities, founded by the French and taken over by the U. S. A. with the Louisiana Purchase. Yet this old main is still withstanding the traffic shock and beam stresses imposed by multi-ton trucks and congested underground utility services in a great manufacturing city. More than thirty other American cities have cast iron water and gas mains in service that were installed over a century ago—indisputable testimony to the strength factors of long life inherent in cast iron pipe.

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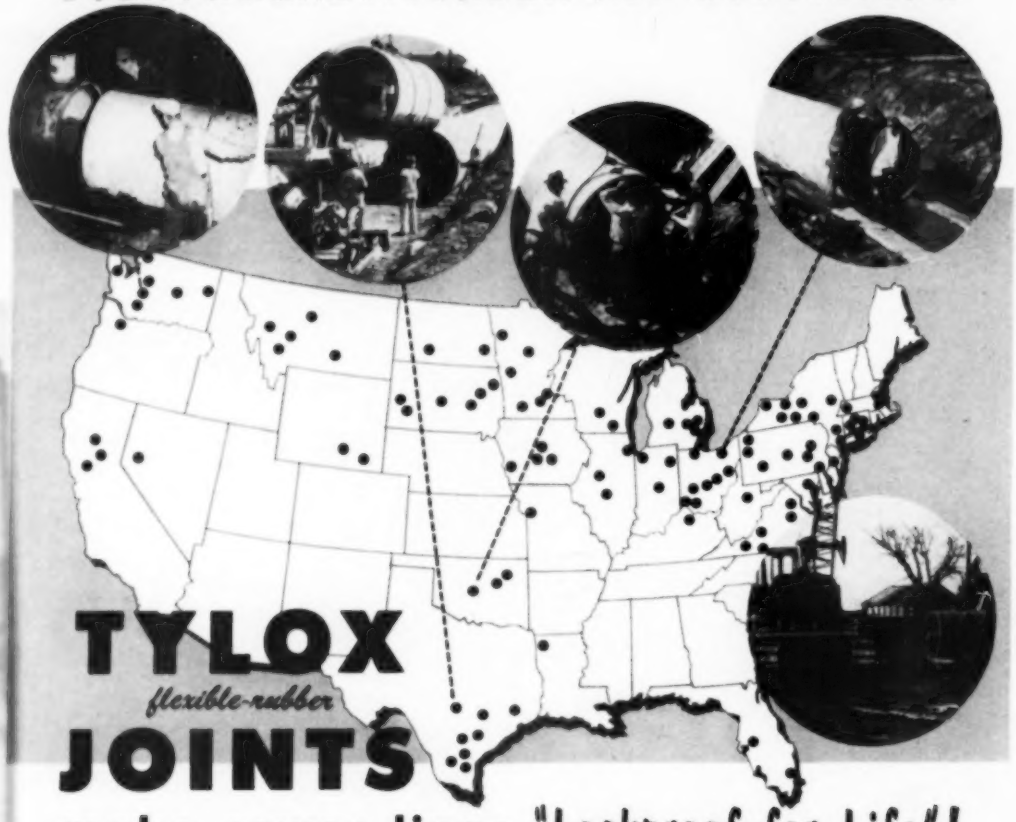

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HERE'S WHY:

The TYLOX JOINT is an all-rubber joint. It is flexible, resilient, chemically resistant, and long lasting. It is easily and quickly applied. It forms a "tight pack." It withstands hydrostatic pressure. It automatically compensates for angularity, soil stresses, and pipe expansion or contraction. It can be used on pipe laid in the wettest ditch or under the hottest sun. It requires no "setting" or "curing" time—permits immediate "back-filling" —gives lower "per laid foot" costs. And, most important, it provides a permanently tight joint that stops leakage or infiltration.

HERE'S HOW:

The TYLOX JOINT consists of a series of pyramid rolls tied together with a center web . It is snapped on the pipe like a giant rubber band. In coupling the pipe, a "pack" is started as the top rolls move to centered positions between the bottom rolls . As the coupling progresses, the pack is completed by the top rolls moving down, between the bottom rolls, into an approximate straight line . In the completed pack, the top rolls are tangent to the bottom rolls inducing true compression throughout the joint and giving a tight, yet flexible coupling.

Be sure of a tight line with the right coupling. Write, wire, or phone for specification data and literature on TYLOX GASKETS!

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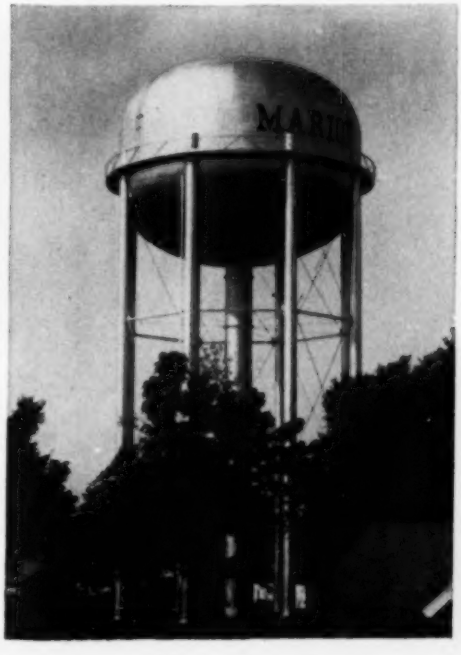
In MARION, Indiana

2 tanks are better than one!



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Moving forward from the practice of pumping deep-well water to transmission mains, the City of Marion, Indiana, now enjoys every advantage of elevated water storage with two strategically-located 500,000-gallon PDM Double-Ellipsoidal Elevated Steel Tanks. Floating on the distribution system, these units create constant high pressures regardless of fluctuating demands, enable continued service in case of power failure, maintain safe reserves for fire protection, and provide uniform head conditions for most efficient pump operation.

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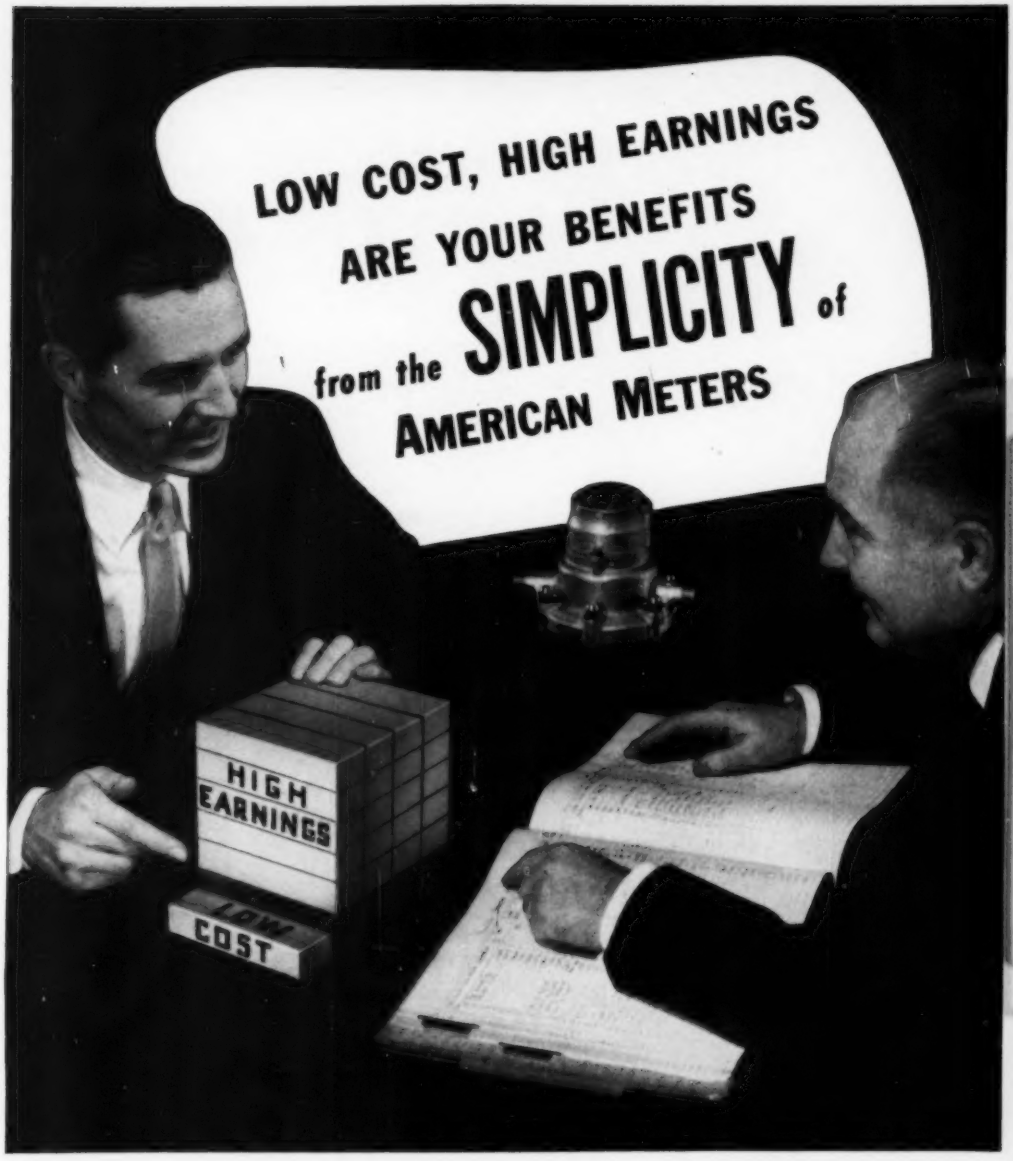

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But impressive as it is, that isn't the whole story. For this Model 33 Engine has been the mainstay of the plant—operating more than 96% of the time . . . generating more than 83% of the plant's total load.

Fairbanks-Morse Dual Fuel Engines are ideal for all generating service. They can produce savings even when operating under unfavorable load factors. Fairbanks, Morse & Co., Chicago 5, Illinois.

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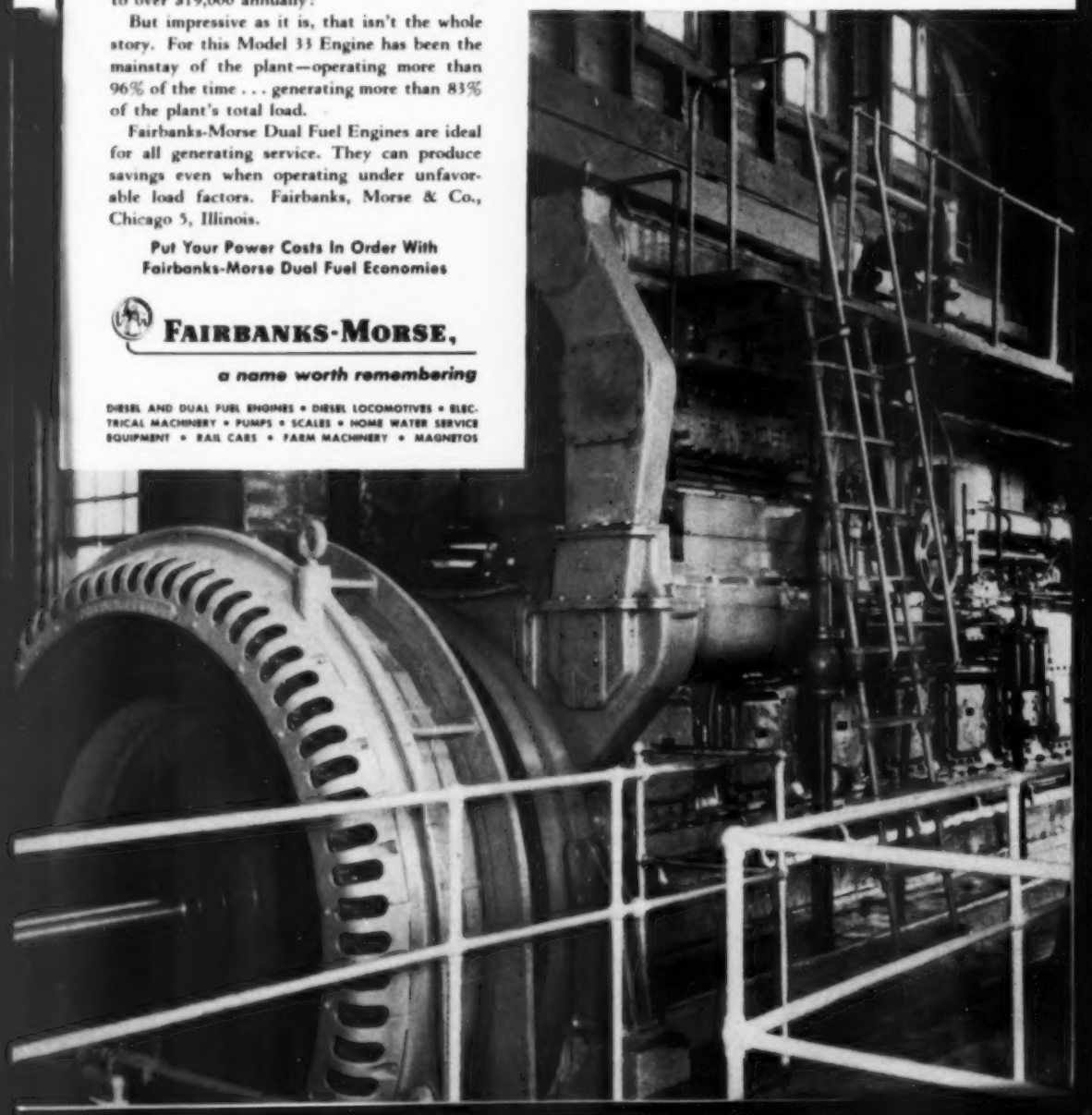

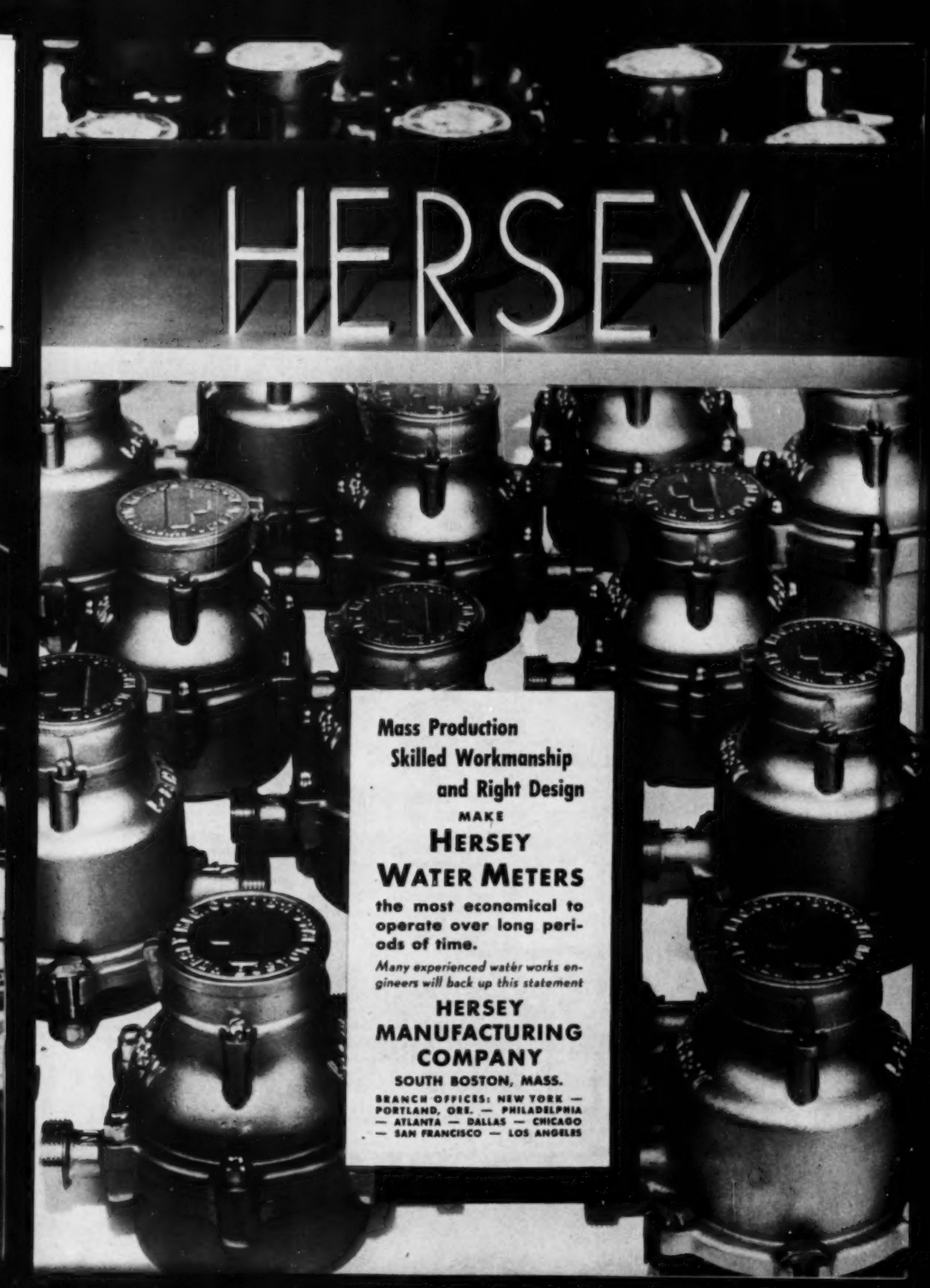
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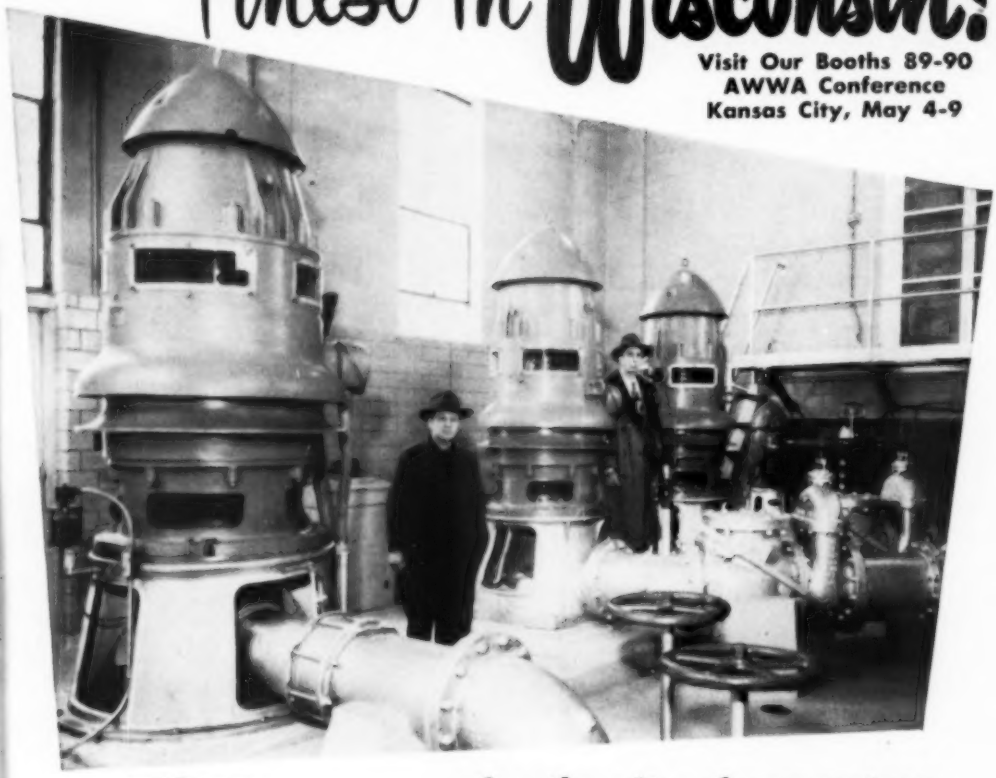

Layne now offers two new folders which fully describe the Layne Oil and Layne water lubricated pumps. Copies will be sent on request. No obligation.

for the city of wauwatosa

*

Layne points with pride to a recent deep well and a four vertical turbine pump installation for the city of Wauwatosa, Wisconsin. From an overall capacity, control flexibility, high efficiency, smoothness of operation and modern engineering, this is one of the very finest water supply plants in the state. The 1750 foot deep well, cement grouted from top to bottom, produces 1650 gallons of water per minute against a dynamic head of 145 feet. All water for the city of Wauwatosa is 100 percent from Layne pumps.

This installation is typical of Layne's all inclusive services. Everything from the original test borings to the well drilling, sand screen and pumps and motors, was handled complete by Layne's own crews operating under the direct supervision of Layne engineers. It is such splendid services and outstanding results that Layne and Layne alone in the Nation, is in a position to offer cities, factories, mills and plants of all kinds, whether the need is for a single unit or for many.

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GENERAL OFFICES, MEMPHIS 8, TENN.

Layne

WATER WELLS

VERTICAL TURBINE PUMPS

WATER TREATMENT

NUCHAR INSURES PALATABLE DRINKING WATER

FIELD TEST REPORT

Tricky Coagulation Plus Odor Reduction Problem Solved By Aqua Nuchar Research Service

PROBLEM: At a New England city, activated carbon was being applied at a rate of 10ppm with little apparent improvement in the quality of the water. The chemist in charge pointed out that not only was this the top limit in feeding capacity, but any higher dosage would add unwanted costs to the chemical budget. A threshold odor survey showed that the water coming into the plant had a threshold number of 40 which remained the same after treatment with 10ppm carbon.

SOLUTION: The first experiment was to determine in the laboratory the amount of carbon needed to effect an appreciable reduction of the odors in the water. Using 1.8 grains alum per gallon to approximate typical plant flocculation, 20, 40, and 60ppm Aqua Nuchar were then added to separate samples of this water. It was noted that the Aqua Nuchar, instead of dispersing, acted as a nucleus on which the floc particles formed, and did not adsorb taste and odor bodies. When no alum was added to the raw water, the Aqua Nuchar was quite effective for removing the taste and odor.

The alum dosage was finally reduced from 1.8 to 1.5 grains per gallon and still remained effective in coagulating and removing the considerable color in the raw water.

This new dosage of alum was tried in the plant with 10ppm Aqua Nuchar. Subsequent observations and studies showed that satisfactory floc formation and odor reductions were obtained.

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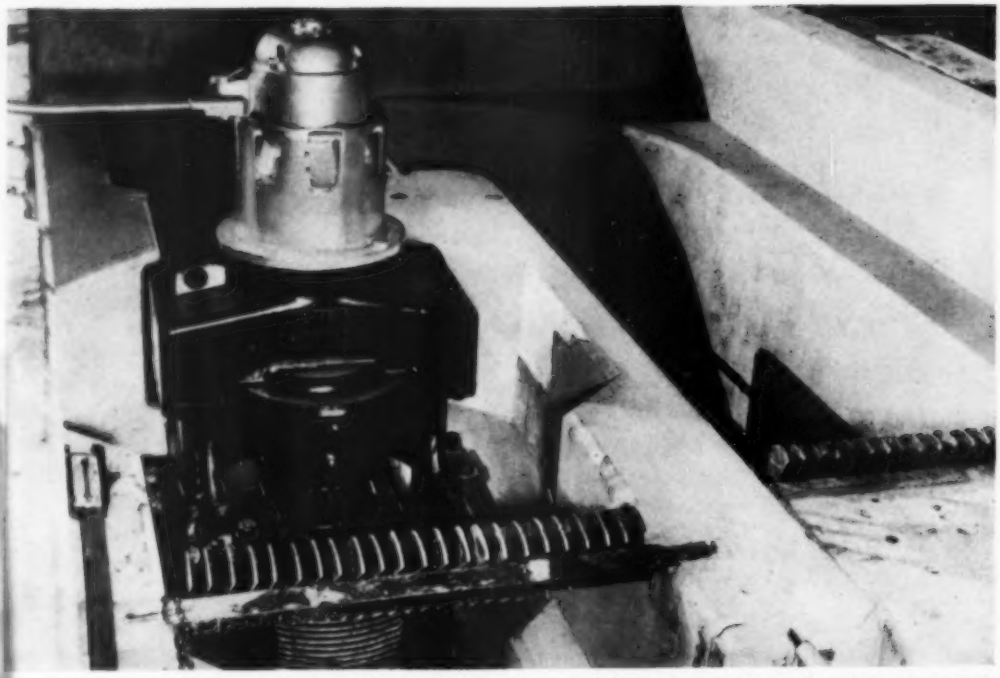


WORTHINGTON COMMINUTOR IS EASILY INSTALLED TO HANDLE LARGE VARIATIONS IN FLOW like this one at the Madison-Chatham (N. J.) Sewage Treatment Plant. Maximum wet-weather flows are occasionally as high as five times the average design dry-weather flow. An overflow screen is installed on top of the comminutor to screen flows in excess of the comminutor's capacity. Screenings are later raked down into the comminutor during period of normal flow. The overflow screen makes the comminutor independent of the by-pass on right which may later be used as a channel for a second comminutor. Plant Superintendent is Edward P. Molitor.

Madison-Chatham, N. J., installation proves adaptability of Worthington COMMINUTOR

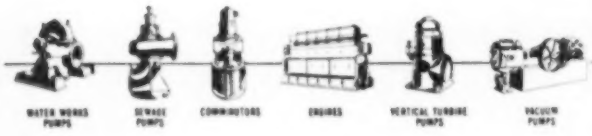
Typical example of the adaptability of the Worthington comminutor is the story of this installation at the Madison-Chatham Joint Meeting Sewage Treatment Plant in Chatham, N. J.

Engineers everywhere especially like the Worthington comminutor because:

- It can be readily installed in new or existing straight-flow rectangular channels.
- Cutter-racks are quickly removable for sharpening or replacement.
- It may be flooded without damage because it's protected by a mercury seal.

Worthington's public works specialists are ready to work with your community's engineer in solving screening problems—as well as other problems in sewage, water works, or municipal power generation. Write for Comminutor Bulletin W-2010-B3. Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Public Works Division, Harrison, N. J.

W-2.5



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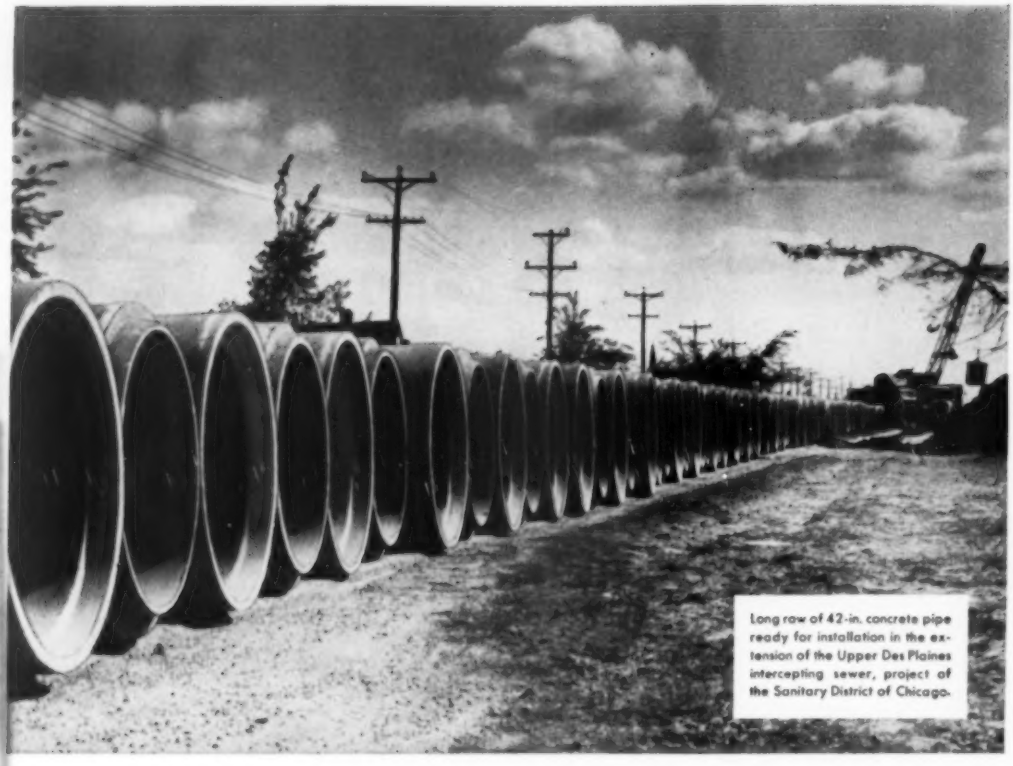

Long row of 42-in. concrete pipe ready for installation in the extension of the Upper Des Plaines intercepting sewer, project of the Sanitary District of Chicago.

Chicago Sanitary District extends sewer service with *CONCRETE PIPE*

The Sanitary District of Chicago, which includes most of Cook county, recently extended its Upper Des Plaines intercepting sewer to provide additional service for outlying residential and industrial areas. The extension was built along North Avenue from the City of North Lake to the existing sewer in the neighboring suburb of River Grove, a distance of approximately four miles. Ultimately about 6,000 acres will be serviced by the new line.

A total of 10,209 ft. of 42-in. reinforced concrete pipe (ASTM specification C-76-41, Table II) was used. The pipe was placed in an open trench 22 ft. deep with a bedding of Class B concrete under and around it to the spring line to a minimum thickness of 8 in. To minimize aftersettlement backfill material was flooded and well tamped.

In hundreds of installations from coast to coast concrete pipe has demonstrated its rugged durability, great structural strength, maximum hydraulic capacity, minimum infiltration and leakage and unusual resistance to abrasive matter. Yet concrete pipe is moderate in first cost, requires little or no maintenance, gives long service. Result: true *low annual cost.*

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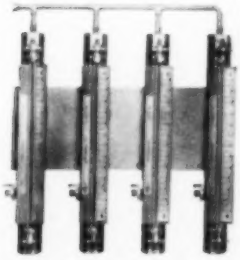
Model 91 Flame Trap

P. F. T. Gas safety Equipment includes Combination Pressure Relief and Waste Gas Flame Trap Units, Flame Traps, Waste Gas Burners for exterior use, Pilot Line Flame Cells, Low Pressure Check Valves, Gas Pressure Regulators, manually operated Drip Traps, Accumulators for Condensate and Sediment, Gas Pressure Indicating Gauges, and auxiliary safety equipment such as Digester Floating Cover Position Indicators. Every unit service-proved in numerous installations — sound engineering evident throughout the line. Typical gas piping arrangements are detailed in Bulletin 221.

Model 92 Pressure Relief And Regulator Valve

Waste Gas Burners

Manually Operated Drip Traps



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Nominal Pipe Size	O. D.	I. D.	Working Pressures P.S.I. @ 120°F	Weight Per Foot	Normal Shipping Lengths
$\frac{3}{4}$"	1.170	.824	120	.216	400' coils
1"	1.433	1.070	120	.285	300' "
1 $\frac{1}{4}$"	1.850	1.380	120	.477	300' "
1 $\frac{1}{2}$"	2.260	1.610	120	.790	250' "
2"	3.000	2.070	120	1.88	200' "
2"	2.495	2.070	75	.620	200' "
2 $\frac{1}{2}$"	2.950	2.470	75	.820	150' "
3"	3.670	3.070	75	1.280	100' "
4"	4.820	4.030	75	2.200	25' straight
6"	7.260	6.070	75	5.000	25' "

Specify the Pipe with the Stripe!

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Maysville Water Company, Inc.

(FLUORIDATION INAUGURATED MAY 1951)

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Consulting Engineers
Cincinnati, Ohio

WILLIAM D. COCHRAN, *Pres.*
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Omega Fluoridation Equipment furnished for the Maysville Water Company, Inc.:

Model 47A Volumetric Fluoridizer with wall-mounted dust collector.

Rate of feed: 1-50 oz./hr.

"First in Kentucky with Fluoridation" . . . that's the motto of the Maysville Water Company, Inc., a private water supply utility which has been serving Maysville, Kentucky, for over 70 years. To meet the strict fluoridation requirements of the Kentucky State Board of Health calls for plant and personnel of extremely high calibre. That Maysville was the first plant in the State to obtain approval of its fluoridation installation may be considered a great tribute to the Water Company, to Frank C. Hunsicker, Plant Supt., and to the operating personnel of the plant.

Omega Machine Company is proud of the part its fluoridation equipment has played in achieving this "first" for Maysville. An Omega Volumetric Fluoridizer feeds the fluoride compound into the treated and filtered water, and, according to actual experience, is maintaining the recommended solution of 1.2 PPM with no noticeable variation. For Bulletins describing Omega Fluoridation Equipment, address Omega Machine Company (Division of Builders Iron Foundry), Providence 1, Rhode Island.

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MECHANICAL-JOINT JOB
WITH
PIPE, FITTINGS, VALVES AND
HYDRANTS

...with EDDY Mechanical-Joint Valves

After excavation, two unskilled workmen and a ratchet wrench can install Eddy Mechanical-Joint Valves in a jiffy. This can mean many man-hours saved each year. What's more, the work can be done in a flooded trench, or in any kind of weather—for no caulking, no lead-melting is needed . . . and all joints are *bottle-tight* under pressure. Valves meet AWWA specifications, and are available in sizes 3" to 12" for use on both sand-cast and centrifugally-cast iron water pipe.

...and EDDY Mechanical-Joint Fire Hydrants

Since 1849 EDDY For Long Service

Mechanical-Joint connection allows quick, easy installation or removal (with or without auxiliary valve). Hydrants also available with bell or flanged connection. All operating parts accessible by removing top cover. Hydrants open fast, close easily. Even a bent stem does not cause water loss, and drip-action prevents freeze-up. Stock up now on both Clow Mechanical-Joint Cutting-in Valves and Hydrants. Be ready to make easy, speedy installations when needed!

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4 major reasons why Permutit is

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WATER CONDITIONING HEADQUARTERS for 40 years, The Permutit Company pioneered in the application of ion exchange in water treatment. Permutit's *complete* line of water conditioning equipment is engineered and constructed to meet all needs.

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Write for further information on these and other types of water conditioning equipment to The Permutit Company, Dept. W-5, 330 West 42nd Street, New York 36, N. Y., or to Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

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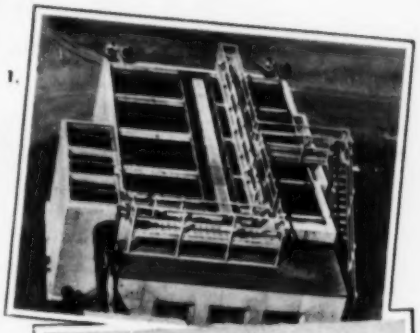

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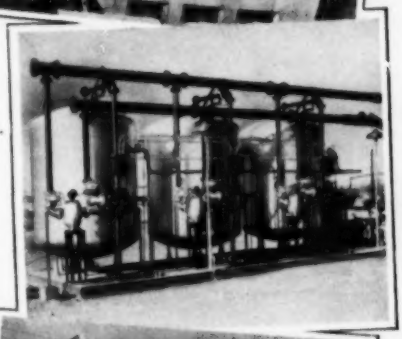

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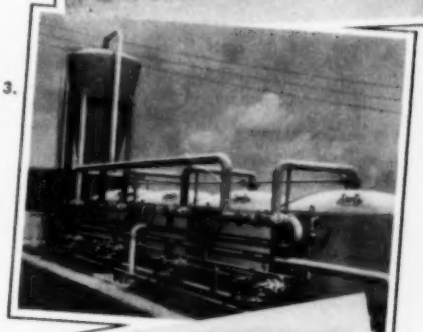

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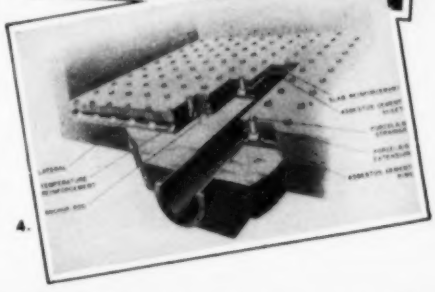

WATER CONDITIONING HEADQUARTERS FOR 40 YEARS

PERMUTIT

Why cast iron pipe

can and does save

Millions of Tax Dollars

The answer, of course, is (1) cast iron pipe serves for centuries, and (2) over 95% of the pipe in service in America's water distribution systems is cast iron pipe. But let's get down to figures.

The cumulative cost of our water supply systems, from 1817 to 1951, is estimated at $6-billion, of which more than $3.5-billion is for cast iron pipe, including installation costs. The balance is for pumping stations, filter plants, storage facilities, etc.

Most of this money was raised by the issuance of bonds. Now, the useful life of cast iron pipe is at least 4 to 5 times the average term of a water revenue bond issue. Records prove that more than 35 American cities have cast iron mains in service that were installed over 100 years ago. A survey sponsored by three waterworks associations shows that 96% of all six-inch and larger cast iron pipe *ever laid* in 25 representative cities is still in service.

Add it all up and the answer is clear that, by serving for generations after bonds issued to pay for them have been retired and forgotten, cast iron mains save many millions of tax dollars.

One of a number of cast iron water mains which have been in service in New York City for more than a century. Over 35 other cities have century-old cast iron mains in service.

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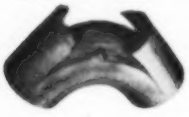
IT TAKES ONLY ONE to install pipe

but FIVE to repair it!

One of the most convincing demonstrations on the economy of using *durable* material is a repair job where low-first-cost material has failed—and is being replaced.

The original installation had been quickly made by pipe fitters. But the replacement calls for hours of work by as many as five crafts: pipe fitter, mason, plasterer, carpenter, painter. And this is only part of the cost story. The loss in production or utilization during the shut-down may amount to far more than the maintenance charge.

True, you pay a little more to *begin* with for Byers Wrought Iron pipe . . . but you pay a lot less to *end* with. In literally thousands of applications where corrosion costs you more than wrought iron, the use of this material is the soundest kind of economy move.



WHY WROUGHT IRON LASTS

This notch-fracture test specimen illustrates the unusual fibrous structure of wrought iron—which is responsible for the unusual corrosion resistance of the material. Tiny threads of glass-like silicate slag, distributed through the body of high-purity iron, halt and disperse corrosive attack, and discourage pitting and penetration. They also anchor the initial protective scale, which shields the underlying metal.

You will find a lot of helpful information on the control of excessive maintenance through the use of Byers Wrought Iron pipe in our technical bulletin, WROUGHT IRON FOR PIPING SYSTEMS. We will be glad to send you a copy.

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Hand and power operated drilling machines for making cuts under pressure. Other machines for tapping and drilling dry or pressure mains.

Model "C-1"

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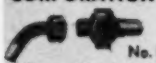

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For machine insertion under pressure. Many patterns for use with cast iron, steel, asbestos cement or wood mains and service clamps.

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Inverted key and solid head patterns. Complete selection of types. Precision made.

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Available in single or double strap styles. For mains up to 12". For steel, wrought iron, cast iron or asbestos cement pipe.

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Telescoping extension-type service boxes Minneapolis Pattern or Arch Pattern. Wide range of lengths and sizes.

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GATE VALVES

Designed and built to exceed AWWA specications.

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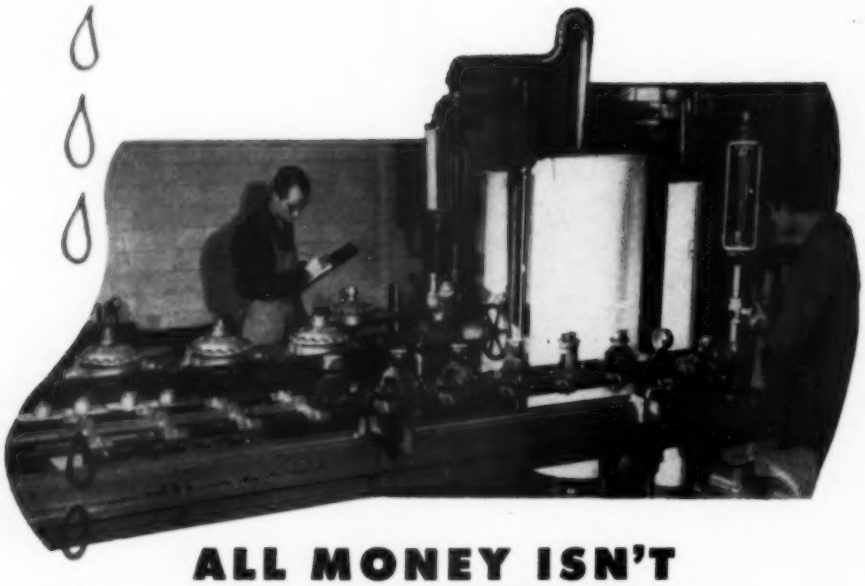

ALL MONEY ISN'T MADE IN THE MINT

¶ When meters lose accuracy, the volume of water unaccounted for at low flows may astonish you. The loss in revenue is in proportion.

¶ One small town (3,000 taps) increased revenue over $2500 per year after putting in a meter-repair program. With their meters testing more accurately at low flows, the increased revenue more than paid for the cost.

¶ At the same time pumpage dropped 2.2%

¶ Proper meter maintenance is vital, but naturally the most important thing is to buy Trident Meters in the first place. That way you keep down maintenance costs and get longest meter life and sustained accuracy.

The SYMBOL of SUSTAINED ACCURACY

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WATER & SEWAGE WORKS

VOL. 99, NO. 5 • A GILLETTE PUBLICATION • MAY 1952

PULASKI'S new plant from the street before landscaping.

Pulaski's New Water Softening and Filtration Plant*

A dual purpose plant with unique features.

by W. MARTIN JOHNSON, *Partner, Wiley & Wilson Engineers, Lynchburg, Virginia.*

ABOUT thirty years ago, the Town of Pulaski, Virginia, developed a small impounding reservoir in the mountains above Pulaski at an elevation from which water could be delivered by gravity to the residential sections and industrial areas of the Town of Pulaski. From time to time, it has been necessary to make repairs to the dam and minor enlargements to increase the capacity to meet the normal growth requirements of the Town. As the water level in the lake lowers, the concentration of iron and sulphur increases and the water stagnates, so to speak. This condition occurs practically every fall and at other times of the year when the demand is particularly heavy and rainfall is light. The impounded water is very soft.

At one time the leaks in the old rock filled dam were extensive and the leakage indicated a high concentration of iron and sulphur at all seasons of the year. During this period the Town installed a small pump to return the leakage through the dam back to the lake in order to conserve water.

Auxiliary Source of Supply

As the annual deficiency of stored water recurred practically year after year, in the early thirties the Town authorities authorized a study and development of Warden's Spring which is a large limestone spring, located east of the Town. This spring has a minimum flow of approximately 2,000,000 gallons per day. The water has a hardness of from 250 to 350 parts per million, depending upon the flow of the spring. At times there is slight turbidity but all known fox holes and crevices in the rocks in the area known to drain into this spring were sealed off and a good quality hard water is now available at all times. The pumping equipment at this spring consists of three 1,000,000 gpd.

* A paper presented before the Virginia Section of the Am. Water Works Ass'n. and released by the Association for publication in *Water and Sewage Works.*

FILTERS and Operating Tables. Corner of Laboratory seen on left.

pumping units which operate at a head of approximately 350 feet. Each year when it became necessary to introduce the hard water into the distribution system, as the mountain storage of soft water became depleted, the usual objections arose from the domestic customers and the usual difficulties resulted at the industrial plants using water for processing purposes. In 1941 a study was instituted for the development of an adequate supply of water for all purposes so a reasonably uniform quality of water could be delivered to the system. The war interrupted and delayed the work. The Town now owns an adequate site on the upper valley of Peak Creek at which an impounding reservoir dam can be constructed to collect and hold soft water which will flow by gravity to the new filter plant in Town. The overflow level at the new site would be the same as the existing reservoir.

Water consumption at Pulaski at the present time averages about 1.25 million gallons per day with peaks of 1.6 million gallons per day. As this flow is still within the combined capacity of the mountain reservoir and the Warden's Spring flow, it was decided to develop a dual purpose water treatment plant which could handle both types of water and postpone the development of a gravity mountain supply.

New Dual-Purpose Treatment Plant

Bids were taken in August, 1950, for the filter plant construction together with distribution system improvements and filtered water storage facilities. Contracts were awarded for the filter plant, pipe line construction, tank foundations and booster pumping station to F. L. Showalter, Inc. The filter plant equipment contract was awarded to the Roberts Filter Manufacturing Company, and the contract for the four steel standpipe tanks was awarded to the Chicago Bridge & Iron Company. These projects consisted of a high level system in the north and another in the south section of town to serve areas not previously supplied with Town water. The distribution system improvements consisted of various connecting lines and the separation of the raw water supply lines from the mountain reservoir and Warden's Spring from the distribution system in order to deliver the raw water from either source directly to the filter plant. These raw water lines which previously served partly as distribution mains were of necessity separated from the distribution system or replaced.

Plant Dedication Dec. 10, 1951
The author and plant designer, Martin Johnson, delivering keys of plant to Mayor H. R. Imboden, publisher of "Southwest Times."

The filter plant has a capacity of 3,000,000 gallons per day and consists of four 3/4 million gallons rapid sand filter units. The mechanical equipment for three filters was included in the initial construction of the project. The fourth filter is ready

to receive equipment as soon as needed.

Plant Operation

The waters from Warden's Spring and the mountain reservoir reach the filter plant through mains from opposite directions which join in a 16 inch main entering the plant. Actually, if the plant is not in operation, it can be by-passed and water from Warden's Spring can be pumped directly to the mountain reservoir for storage if necessary.

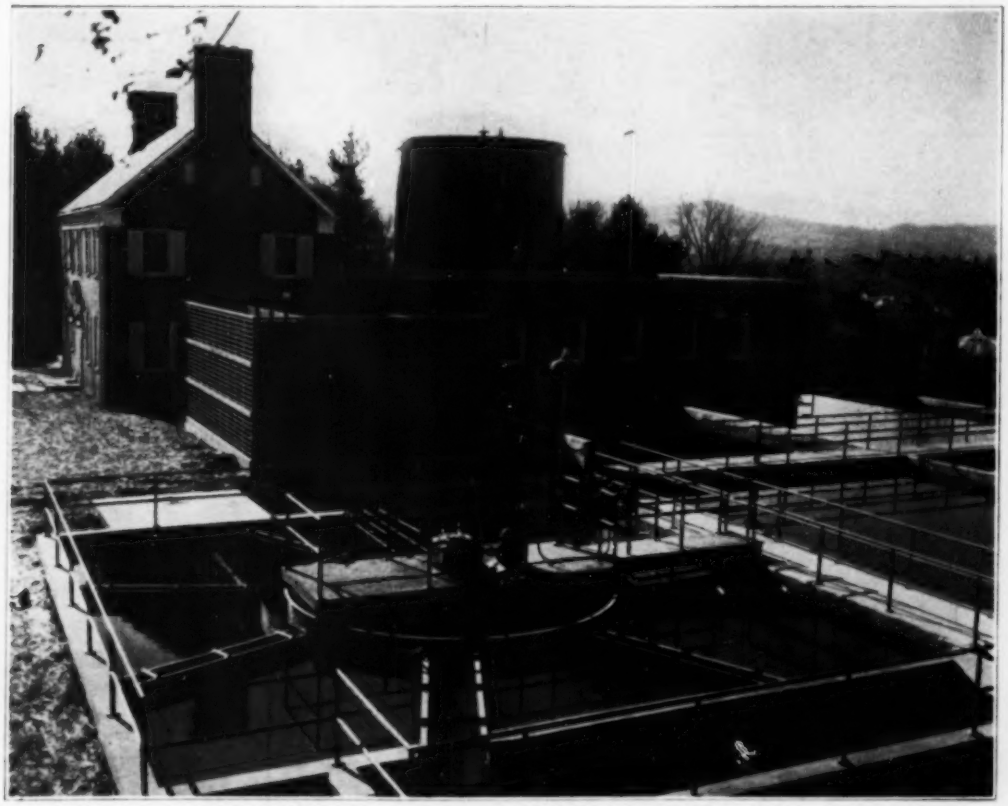
When the soft water is being drawn from the mountain reservoir, it will first pass through the coke tray aerators to stabilize the iron and sulphur, after which the water will be treated with alum, soda ash or lime depending upon the requirements of the water. After this the water enters the mixer basin which is equipped with an Infilco "Accelator" with some modifications to meet the requirements of the dual purpose of this plant.

When water is taken from Warden's Spring the aerator is by-passed and lime is added at the entrance to

Plant Plaque

the "Accelator" basin and softening will be accomplished by the so-called excess lime treatment. The precipitate from either the soft water or the hard water will be substantially settled in the "Accelator" basin and the remainder will be collected in the settling basins before reaching the filters. On leaving the "Accelator" basin, the water passes through the carbon dioxide contact chamber and if excess lime softening is being used, carbon dioxide will be diffused through the water for recarbonation of free lime which is precipitated as calcium carbonate in the coagulation basin. The carbon dioxide is supplied by an oil fired CO_2 generator and the gas purified before being pumped to the diffusers in the bottom of the contact chamber. Brick baffle walls are provided at the entrance to the coagulation basins to distribute uniformly the flow of water into the basins. These basins provide a 5.25 hours settling period, ahead of the filters, based on the maximum capacity of the plant. The "Accelator" basin and equipment were selected in place of either the conventional horizontal or vertical type mixers in order to benefit from the sludge blanket contact and to obtain a substantial degree of precipitation of floc or lime sludge before the water enters the coagulation basin.

During several months of each year, the impounded mountain water is of such quality that plain sedimentation in the coagulation basins will suffice to deliver a good quality of water to the filters, in which case neither chemicals or mixing will be required. This con-



GENERAL VIEW of plant, looking across "Accelator," coke-tray aerators and basins.

FILTER GALLERY and turbine type deep well pumps for delivery of finished water.

dition may obtain during the winter months when there is a reasonably good overflow at the mountain reservoir dam.

Filters

The filters are the rapid sand type and each filter is equipped with hydraulic valve operators, Palmer Surface Wash units and Wheeler Bottom underdrains. The Wheeler type underdrains were obtained on the basis of alternate bids for various types of nonferrous underdrainage systems. Wash water is supplied to the filters from the general distribution reservoir located on the plant lot. The water can be applied at any desired rate, normally 20 gallons per square foot per minute of filter surface. The rate of back washing is controlled by a wash water rate of flow controller located in the pipe gallery.

Chemical Feed

The chemical feeders are the dry type and are located on a platform above the main filter floor level and from which the chemical solution can be fed by gravity into the raw water. Chemicals are stored on the second floor of the building and are fed by gravity into the storage hoppers of the feeders. Three feeders have been installed and space for an additional unit is provided. These feeders are for alum, soda ash or lime, depending upon the condition of the raw water. The "Calgon" feeder is provided in the chemical feed room for the post treatment of the water to reduce corrosion. Either "Calgon" or soda ash treatment of the finished water is desirable regardless of the source of supply of the raw water. It is intended to soften the Warden's Spring water to approximately 3.5 grains (60 ppm.) hardness, but even this will be noticeable to the water users unless some form of post treatment is provided. The mountain water contains less than 1 grain of hardness and even after treatment should not exceed 2.0 grains hardness, and would normally have an aggressive quality.

Finished Water Pumps

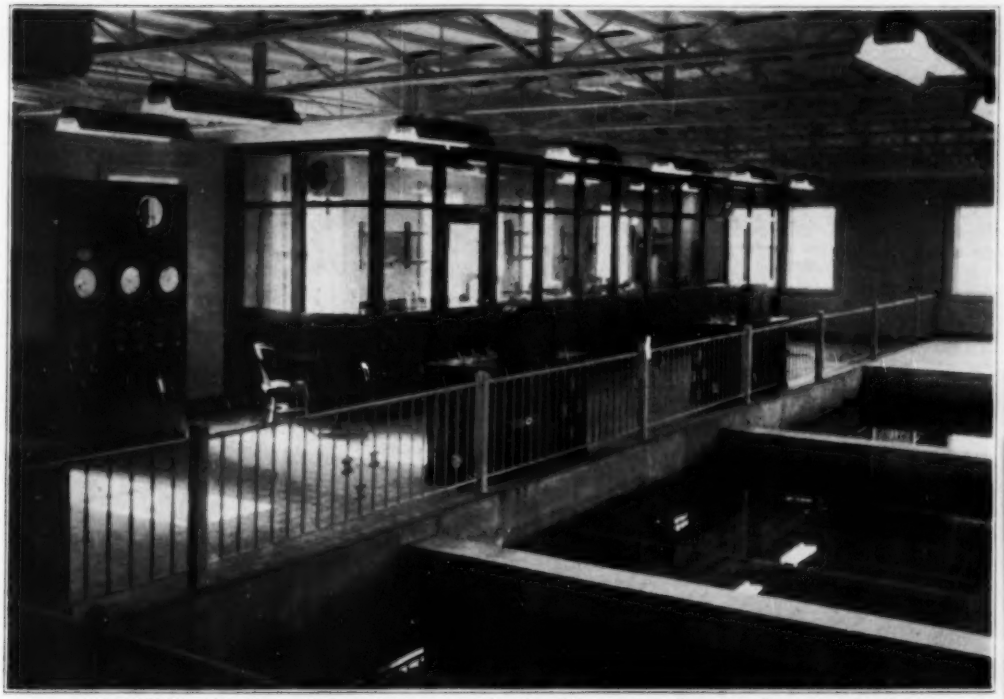
The three lift pumps for transferring water from the clear well to the general distribution system level are deep well turbine type pumps. This type of pump conserves floor space and eliminates priming facilities or foot valves in the clear well, and at the same time obtain high pumping efficiencies. There are two booster pumps located in the filter plant for delivering water from the general distribution system to the north high level system. There is also a small booster pumping station located in the south section of the Town to supply the South high level system. While the water reaches the filter plant from the mountain supply and passes through the filter plant by gravity it is necessary to lift the water approximately 40 feet from the clear well to the general distribution system.

Laboratory and Building

A modern fully equipped laboratory, conforming to the requirements of the State Health Department, is located on the filter operating floor so that the operator gets full view of the filter gallery, chemical feeders, and pump control panels from one point. A sample table is located inside the laboratory for quick observation and testing of the water samples from various parts of the plant.

The building, located in Jackson Park, is of reinforced concrete and brick construction and fortunately of such size that the plant was adaptable to colonial residential type of construction, conforming to some of the fine homes in the vicinity of the filter plant. The brick construction is cinder block with brick veneer exterior, waterproofed by parging the interior joint between the cinder block and the brick. The front part of the building presenting the residential appearance has a slate covered gable roof and the rear of the building enclosing the filters is of flat deck construction. The original plans called for common brick

PIPE GALLERY, showing inlet valves for hard spring supply and soft mountain supply.



LABORATORY within glass enclosure and plant control board on filter operating floor. Note flat roof construction.

exterior walls to be painted white, but the contractor produced such a creditable job of brick work, which is very unusual these days, that painting was omitted and a most attractive red brick structure is the result.

Office space is provided in the front part of the main floor, and lockers and toilet rooms are also available in this section of the building. A freight elevator is provided for hoisting chemicals from the driveway platform to the chemical storage room.

Heat is furnished by an oil fired steam boiler with unit heaters and radiators serving the individual spaces. Oil was selected since it is required for the carbon dioxide generator and so that the flue gas from the heating boiler may be used for carbon dioxide during the heating season and the carbon dioxide generator used only during hot weather. The waste heat from the generator is removed by circulating filtered water through the heat exchanger.

Howard C. Jackson
Sup't. of Water & Pub. Wks.
(Succeeding his late father.)

The plant is situated on a large plot of ground originally owned by the Town for a standpipe and small park, now named Jackson Park for Pulaski's long-time Supt. of Water and father of Howard Jackson, who succeeded him as Supt. of Water. The plant is located in one of the best residential areas and the grounds are appropriately landscaped to present an inviting appearance to visitors who will always be welcome at the plant. Pulaski has therefore accomplished a big step towards the modernization program of its water supply and is now in a position to meet the requirements for water at all times, regardless of the source of supply, and to encourage industry to locate in Pulaski. In addition the town has in reserve mountain property for a future reservoir when conditions require these expanded facilities.

SUPPLIERS OF MAJOR EQUIPMENT

Filter Equipment	Roberts Filter Mfg. Co.	Turbine Type Pumps	Worthington Corp.
Coke Tray Aerator	" " " "	Centrifugal Pumps	" "
Venturi Meters	Simplex Valve & Meter Co.	Chemical Feeders	Wallace & Tiernan Co.
Rate Controllers	" " " " "	Chlorinators	" " " "
"Accelator" Clarifiers	Infilco, Inc.	Elevator (chemicals)	Westbrook Elev. Mfg. Co.
CO_2 Generator	" "	Tank (at plant)	Chicago Bridge & Iron Co.
CO_2 Compressor	Nash Engineering Co.	Gen'l. Contract	F. L. Showalter, Lynchburg, Va.

AWWA Convention Program

Received too Late for Pre-convention Printing but Here Reproduced
For Information of Convention Non-attendants

THE TECHNICAL PROGRAM for the 72nd Annual Convention of the Am. Water Works Assn. was not released in time for printing in our April issue. Realizing that this issue will not reach subscribers until the convention is either well under way, if not already over, we are printing the program for the record and in order that those of our readers who have not seen it previously may see what topics were discussed and by whom.

As is the custom, this magazine will print a general account of the Kansas City Convention and follow up with digests of the papers and discussion, beginning with our next issue. We regret that the account can not appear until a full month after the convention is over, this being due to the circumstance that the closing date for our June issue is May 1st, and the Kansas City Convention opens May 4th, and closes on the 9th.

The Program

Monday Morning—May 5

WATER PURIFICATION DIVISION

Open-Air Reservoirs—*Committee Report*
NORMAN J. HOWARD, *Chairman*

Instrumentation and Methods for Testing Radio-active Contamination in Water
(Task Group Report)
H. H. GERSTEIN, *Chairman*

A Study of "So-Called" Electrical Treatment of Water for Boilers
ROLF ELIASSEN, H. H. UHLIG

WATER WORKS MANAGEMENT DIVISION

Selling Rate Adjustments to the Citizens
[*An Experience Panel*]
LEONARD N. THOMPSON, *Moderator*

D. L. ERICKSON — WENDELL R. LADUE
MORRIS S. JONES — ALFRED O. NORRIS
J. CLARK KEITH — RAY L. SHEPARD
A. P. KURANZ — C. F. WERTZ

The Place of the Manufacturer in the Water Works Industry
WILLIAM J. ORCHARD

The Water Works Industry Needs a Safety Program
GEORGE MACDONALD

Monday Afternoon—May 5

WATER PURIFICATION DIVISION

Slurry Feeding of Activated Carbon
JOHN R. BAYLIS

A Flotation Process for Water Purification
S. H. HOPPER

The Application of Molecular Filter Membranes to Specific Problems in Water Testing
ALEXANDER GOETZ
R. H. GILMAN
A. M. RAWN

WATER WORKS MANAGEMENT DIVISION

GETTING ALONG WITH:
Mayors and Councils ..... GEORGE PATE
Employees and Customers ..... ROBERT MILLAR
A Boom Municipality ..... VIRGIL KNOWLES

MEETING FLOOD PROBLEMS—
PANEL DISCUSSION
L. P. COOKINGHAM, *Moderator*
Establishing Emergency Authority ..... M. P. HATCHER
Notifying the Public ..... N. S. BUBBIS
Shutting Off the Plant ..... UEL STEPHENS
Emergency Water Supply ..... MAJOR C. HAGAR
Restoring Service ..... FRANK E. WILLEY

Tuesday Morning—May 6

THE KANSAS FLOOD OF 1951

What Happened? How Much Rain? How Much Stream Flow?
N. T. VEATCH

Interruptions to Water Service:
Quality and Treatment ..... D. F. METZLER, RUSSELL CULP
Production and Distribution ..... R. G. KINCAID
What of the Future? ..... ARTHUR CARHART

Tuesday Afternoon—May 6

WATER PURIFICATION DIVISION

Some New Ideas in Water Treatment Plant Design
THOMAS M. RIDDICK

The New Insecticides and Their Effect on Water Quality
LOUIS F. WARRICK

Taste and Odor Problems in Spring Runoff
(Panel Discussion)
J. F. ERDEI, GEORGE S. LEE, LEO LOUIS, M. P. POWELL, JAMES SAMPSON

SYMPOSIUM ON WATER HAMMER

Introduction to New Division
A. E. BERRY

Are Standard Allowances for Water Hammer Desirable on All Types of Water Works Piping?
S. LOGAN KERR

Standard Allowances From the Viewpoint of the Consulting Engineer
FRANK A. MARSTON

Should Existing Information for Standard Allowances for Cast-Iron Pipe Be Revised?
THOMAS F. WOLFE

Are Standard Allowances Needed for Steel Pipe in Water Works?
WALTER H. CATES

Are Standard Allowances Needed for Asbestos-Cement Pipe?
A. J. MAAHS

Are Standard Allowances Needed for Reinforced Concrete Pipe, Combination Lock-Joint Pipe, and Prestressed Lock-Joint Pipe?
HUGH F. KENNISON

General Discussion of Above Papers
CHARLES H. CAPEN
SAMUEL B. NELSON
L. G. LENHARDT

Wednesday Morning—May 7

GENERAL SESSION

Sea Water as a Source of Fresh Water
E. D. HOWE

Discussion by: W. F. LANGELIER

Review of Legislative Proposals and Enactments on Weather Control—*Task Group Report*
E. H. GUYER, *Chairman*

Rain Increase Projects in Relation to Water Resources
IRVING P. KRICK

STEEL PIPE COMMITTEE
(Open Session)

Committee Progress Report W. W. HURLBUT
H. ARTHUR PRICE

Installation Procedure for Large Diameter Pipe
MAX SOCHA

Some Developments in Tests of Coatings for Steel Pipe GRAYDON E. BURNETT
CHARLES B. MASIN

The New Standards for Steel Water Pipe Flanges
H. O. HILL

Wednesday Afternoon—May 7

WATER RESOURCES DIVISION

Ground Water Recharge FINLEY B. LAVERTY

Control of Underground Waste Disposal
NORMAN F. BILLINGS

Artificial Ground Water Recharge—*Task Group Report*
C. H. BECHERT, *Chairman*

Industrial Water Use—*Task Group Report*
HERBERT E. HUDSON JR., *Chairman*

WATER WORKS MANAGEMENT DIVISION

A Census of Fluoridation—Natural and Applied .....
O. J. MUEGGE

Experiences With Fluoridation—*A Superintendents' Panel*
W. VICTOR WEIR, *Moderator*

WALTER M. FRANKLIN GUY MORROW
JAMES E. KERSLAKE JOHN H. MURDOCH
JOHN E. KLEINHENZ GEORGE W. PRACY
JEROME C. ZUFELT

Open Discussion

Thursday Morning—May 8

WATER RESOURCES DIVISION

Evaporation Research at Lake Hefner
EARL HARBECK JR.

Discussion by: M. B. CUNNINGHAM

Long-Range Water Supply Planning for Wichita
ROBERT H. HESS

Sealing of Wells—*Committee Report*
JAMES C. HARDING, *Chairman*

Discussion by: O. J. MUEGGE

FOURTH DIVISION

River Intakes on Variable Streams
VANCE C. LISCHER
HERBERT O. HARTUNG

A Study of Jute and Other Yarning Materials Used in Bell and Spigot Pipe
CHARLES A. BLACK

Discussion by: MARSHALL P. CRABILL
WILLIAM E. HOLY

A Survey of Service Line Installation Practices
WALTER A. PEIRCE

Thursday Afternoon—May 8

WATER WORKS PRACTICE COMMITTEE OPEN SESSION

Committee on Water Works Practice
LOUIS R. HOWSON, *Chairman*

WATER ADMINISTRATION COMMITTEE OPEN SESSION

Committee on Water Works Administration
WENDELL R. LADUE, *Chairhan*

Friday Morning—May 9

SESSION ON FEDERAL ACTIVITIES

Emergency Repair and Operation of Water Facilities in Disaster—*Civil Defense Report*
JOHN S. LONGWELL

Discussion by: M. B. CUNNINGHAM

Relocation of Water Works Facilities in Highway Construction:
Engineering and Financial Aspects....HARRY B. SHAW
Legal Aspects.....G. H. SEIG

Construction and Maintenance Controls
GERALD E. ARNOLD

Discussion by: E. H. ALDRICH

Municipal Water Supply of Scandanavia

Part II—Copenhagen, Denmark

by E. L. KNOEDLER, *Senior Eng'r, Sheppard T. Powell, Eng'rs., Baltimore, Md.*

THE importance of the water supply problem of the City of Copenhagen has been recognized for more than 800 years. During the early history of the town, inhabitants obtained their water from "draw-wells"—most of them framed with oak planks. Apparently, almost every house had a well of its own and, in addition, there were public wells at the market places and in some of the streets.

Copenhagen's First Water Supply

By the end of the sixteenth century, unfiltered surface water was conveyed into the town from nearby lakes. Both the main and branch lines of the distribution system consisted of bored out tree trunks and, since the lakes were situated in low ground, the water had to be pumped to most of the houses. Certain main conduits belonged to the King and others were owned by private water companies which operated them on concessions. Gradually the streets of the town became honey-combed with wooden pipe lines, the interior diameter of which was only about 5-in. Similar construction was used in many other water supplies in Denmark.

Although several wells yielded a good quality drinking water, the water from the conduit system was quite inferior. It was turbid, odorous and unpleasant tasting. This condition was due partly to sewage contamination of the water in the lakes, and partly to pollution through leaks in the pipe joints—which allowed entry of drainage from the garbage dumps on which sections of the town were constructed.

In 1671, when a committee met to consider means for improving the water supply, the well-known mathematician and physician, Professor Rasmus Bartholin, made the suggestion that the surface water should be purified by a scheme of sand filtration. Unfortunately, the concept was in advance of its time and was not adopted. In 1812, the water companies were abolished and the water supply was placed under a Royal Water Commission.

Early Sand Filtration

Attempts to improve the water supply conditions were unsuccessful until in 1849 a prize was offered for the best method for obtaining a satisfactory water. L. A. Colding, a Danish Civil Engineer, proposed a plan which was adopted. It consisted of accumulating water of the Harrestrup Rivulet together with water from various dug wells in Damhus Lake. These mixed waters from the reservoir were conveyed by an open canal, protected from pollution by parallel intercepter ditches, to sand filters which followed early English design. The filtered water was pumped by steam pumps into a distribution system of cast iron piping for delivery to individual homes.

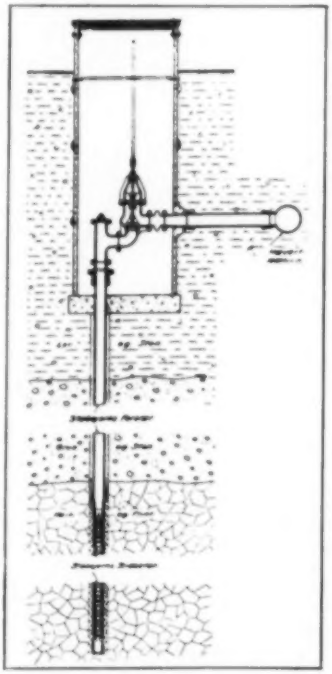


Fig. 1—Typical section of boring for 250 mm. water well.

With continued growth of the city, additional water had to be brought into the system, and some of this was obtained from underground sources. The beneficial effect on the quality of the water, resulting from the addition of the ground water, led to the conclusion that ground water should be the basic water supply for the Copenhagen area.

Impetus was given to the use of well water when borings showed that large quantities of underground water apparently could be obtained from the deeper subterranean strata. As well water began to replace the surface water, open canals were abandoned in favor of covered concrete conduits which thereby reduced contamination from pollution and made it possible to supply more nearly sterile water.

As a result of the long history back of the water supply problem for Copenhagen, a great deal of work has been carried out in studying the available underground supplies and means for collecting and distributing the water to the city centers. Thus, it is apparent that the problem of obtaining a municipal water supply for Copenhagen is of an entirely different nature than in the other three countries discussed.

Underground Water Characteristics

There are no large lakes or rivers and water must be obtained from underground sources. Unfortunately, there are several problems attendant to securing well water from an island source. Salt water infiltration occurs if wells near the coast are pumped too hard. In addition, there is a large amount of methane dissolved in some of the water. This constitutent causes serious problems; sand filters to which it is applied plug rapidly, since bacteria feed on the methane, and within 24 hours water will not pass readily through the units.

An unusual collection system has been developed to supply Copenhagen with needed water. Quite complete geological and hydrological surveys have been made over an area considerably larger than that in which the present water supplies are obtained.

A sufficient number of test holes were bored to determine the direction of flow of the ground water toward

the sea. By this means it was possible to determine the water levels and thus draw constant water horizons and locate the low levels to which the ground water permeated. Using the information obtained from their studies, the engineers were able to locate pumping stations in what appeared to be an underground valley to which most of the underground water normally tended to flow.

In one or two places the water is drawn from wells, but principally it is obtained from borings. These have in almost every case been carried down into the limestone, and their depths range from about 50 to 250 feet. Ordinary mild-steel well tubing becomes badly corroded by the ground water in the course of time and, therefore, asphalted cast-iron tubes are used. The lower portion of the tubing is pierced by a large number of narrow, vertical slits, through which the water flows in freely, while stones and gravel are kept out. In fine gravel and sand layers the slits are covered by bronze net or spirals of bronze wire. A typical well is shown on Fig. 1.

The ground water has a uniform temperature of 47 to 48° F. all the year round. It is free from pathogenic bacteria and contains no noxious substances. Chemical and bacteriological examinations are made ata regular intervals, both by the city medical authorities and the water department laboratories. A typical chemical analysis is shown on Table I.

Present Well Supplies

Wells are spaced several miles apart throughout this area and are manifolded together to form a well supply system which is divided into five groups:

1. The southern group includes the plants at Thorsbro with sub-stations at Store Vejleaa, Vallensbaek, Taastrup Valby, Vardegaard and Karlslunde.

2. The southwestern group includes the plants at Lejre and Marbjerg, covering the more distant groundwater areas to the west and southwest of the city. The plant at Lejre was visited by the author, since it is one of the most modern.

3. The western group includes the water-collecting plants and raw-water pumping stations at Nybolle and the "Springs" with the filter plant and main pumping station at Islevbro.

4. The northwestern group includes the plants ata Sonderso with substations at Bogogaard, Bjellekaer, Kildedal and Egholm.

5. The northern group includes the plants at Vildbjerg with five raw water pumping stations at Stro, Havelse, Slangerup, Attèmose and Aebelhôlt. Plans for these latter were prepared but construction was not yet started by 1949; however, part should be completed during 1952.

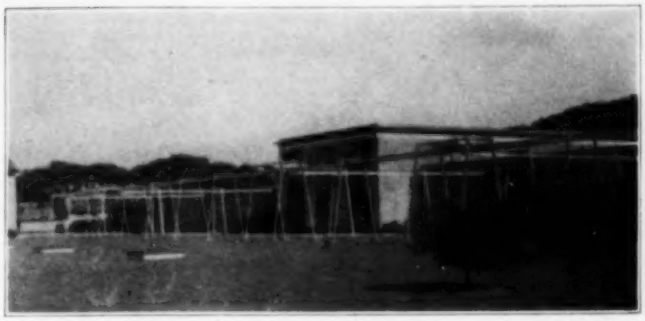


FIG. 2—LEJRE Works, largest and most modern of plants serving the city of Copenhagen.

In order to simplify the operation of using individual pumps at each well, thereby requiring complicated controls, a header from the various wells is connected into a large vacuum vessel adjacent to the filter plant. A vacuum is then applied to the system through the storage vessel and the wells become the equivalent of free flowing wells. This is possible because they are located in the area to which the underground water naturally flows, thus maintaining constant water level conditions. Several alternate systems were installed in this manner and are brought cross-country to the vacuum vessel.

The largest and most modern of the water department plants is the Lejre Works shown in Fig. 2 situated about 25 miles from Copenhagen. In conjunction with the Lejre Works there are seven water yielding areas with collecting systems radiataing from the works and following the valleys of small rivulets. The position of the water yielding areas on which a total of 127 borings are placed is indicated in Fig. 1. The borings are 10-inch bore holes with 5-inch diameter cast iron casings, having slits contiguous to the water-bearing strata of gravel, greensand, marl and limestone. The deepest borings have a depth of about 275 feet, and one well was carried down to 330 feet, but the deep ground water proved to be so saline the well was plugged with concrete. Some of the water has undergone a natural ion exchange in the zeolitic greensand layers so that the water is soft and contains sodium bicarbonate similar to that found in many areas in this country.

On the three southern water well fields, the ground water level is so high that the water is carried directly by siphons to the aeration plant at Lejre through three long cast iron siphon mains 24-inches in diameter. The siphons range from 2 to 5 miles in length, and are said to be the longest in the world.

Table I

ANALYSES OF WATER FROM THE DISTRIBUTION SYSTEM OF COPENHAGEN, DENMARK

Constituents	As	ppm.
Calcium	Ca	91.00
Magnesium	Mg	17.00
Sodium	Na	62.00
Chloride	Cl	74.00
Sulphate	SO_4	49.00
Nitrate	NO_3	0.00
Bicarbonate	HCO_3	342.00
Silica	SiO_2	16.00
Iron*	Fe	0.02
Manganese*	Mn	0.01
Ammonia	NH_4	0.00
Sum		651.03
As Calcium Carbonate:		
Calcium Hardness		228.0
Magnesium Hardness		70.0
Total Hardness		298.0
M Alkalinity		417.0
Oxygen Consumed from Permanganate		6.8
Evaporated Residue		504.0
pH		7.55

* Filtered water.

Unique Design Features

The Danes have developed a unique water supply system which has required imagination and patience to develop. We could learn much from their practice in connection with well supplies that would be applicable to similar conditions here.

In addition to the vacuum system, the engineers installed one pump house on each main return line. The pumps are propeller type units driven by A.C. commutator motors which permit adjusting the rate of pumping speed from the main filter plant. They are so designed that when operating at full load they balance the friction losses in the header systems, and thus increase the flow rate approximately 50 per cent.

Control boards in the filter plant permit the operators to select indi-

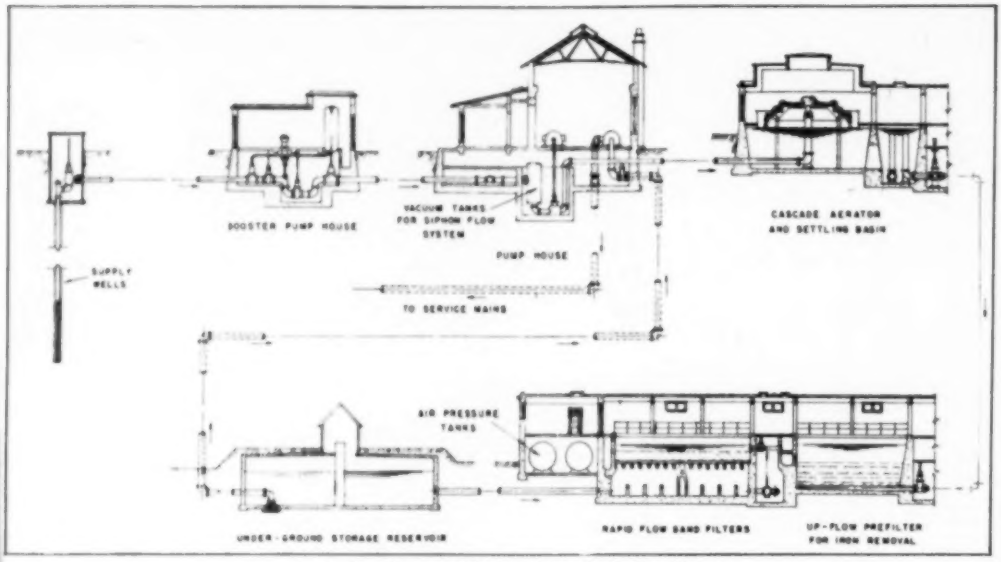


Fig. 3—Flow Diagram of the Lejre Water Purification Plant.

vidual pump houses and adjust the pumping rate as required during high load periods. During normal periods, the vacuum supplies adequate water for the municipal needs.

The Lejre Works

A schematic flow diagram of the water treating facilities at Lejre is shown in Fig. 3. Raw well water is pumped from the vacuum vessel to an aerator to aid in the removal of iron. The water falls in sheets over the cascade aerator and then passes through a system of 8 pre-filters, followed by rapid sand filters. The pre-filters are designed so that they may be backwashed with water following agitation with compressed air. The rapid sand filters are backwashed with water which is forced upward from the sub-chambers of the filters by compressed air.

The pre-filters have a total area of 2150 square feet and the rapid sand filters a total area of 5400 square feet. They are placed symetrically on each side of the aerator. The pre-filter material consists of coarse particles 40 to 50 millimeters in diameter. The rapid sand filters have an 18-inch layer of sand 0.8 to 1.0 millimeters in diameter supported by four, three-inch layers of larger material. It is of interest to note that filter sand employed in the U.S. is much finer than that used in these plants.

The normal filtration rate in the filters is 5 gal. per min. per sq. ft. in the pre-filters and 2 gal. per min. per sq. ft. in the rapid sand filters. The filter system has a maximum capacity of 16 m.g.d. The filtered water is delivered to a submerged reservoir having a capacity of 1.3 mg. Then it is pumped by means of 725 hp. Diesel driven high pressure centrifugal pumps through a 25 mi. reinforced concrete main of 42-in. diameter to the high level reservoirs. The pumps are shown in Fig. 4.

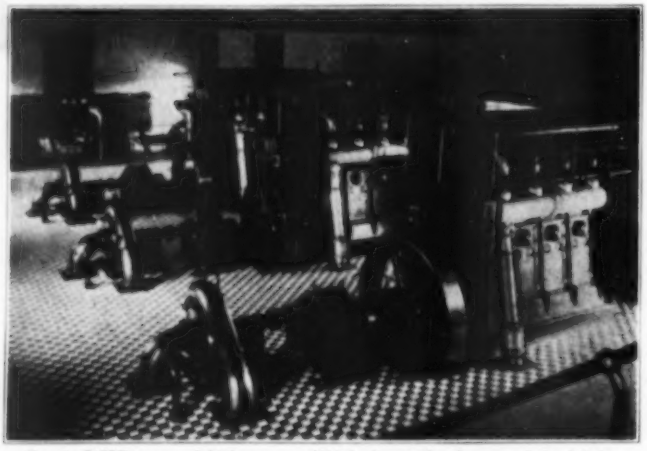


Fig. 4—DIESEL powered high pressure (725 hp.) centrifugal pumps, Lejre Works.

Future Needs

It is necessary to expand the present municipal supply, due to the increasing usage of water as the city has grown to a present population of about 760,000. The per capita consumption which has been increasing steadily is included on Figure 3.

Investigations have revealed that the areas now available for further well development are those in which natural zeolite beds are mixed with the other sand producing acquifers. Well water obtained from these areas contains appreciable quantities of methane. Aeration of this ground water, which originally contains no oxygen, appears to make the methane accessible to bacteria. This results in abundant growth on the filter beds and causes plugging in a short time.

Experience obtained at some smaller towns where well water supplies

had to be developed from similar aquifers has demonstrated that if the methane is removed by aeration or deaeration, the water then can be treated in a normal manner to yield a high quality supply. Apparently, the zeolite beds have a catalytic action in the production of methane because in areas free of zeolite material methane is not found.

The Copenhagen water supply is clear and free from pathogenic bacteria. It is the only water supply of the four studied in which chlorination is not practiced. It is claimed that there is no need for chlorination of the supply because of the careful manner in which it is treated. No difficulty has been experienced from lack of chlorination practice. However, samples are taken regularly and shipped to Mr. Albert Hansen, Consulting Engineer in Copenhagen, where extensive tests are performed regularly. Whenever the operators suspect any difficulty with the water, additional samples are collected immediately and bacterial examinations are made.

The author wishes to express his appreciation to the following for their courtesy and helpfulness:

Engineer Pape for his assistance and kindness in conducting the author through the Lejre Plant and in making available information prepared by Director Martin Udsen regarding the history and water treating facilities of Copenhagen; Mr. Albert Hansen, Director of the Alfred Jorgenson Laboratory of Fermentology of Copenhagen, in making analyses available and in arranging for the writer to visit the city water plant.

[The next article in this series will discuss the water supply of Stockholm, Sweden.—Ed.]

Paul D. McNamee is Dead

Paul D. McNamee, Assistant Superintendent of the District of Columbia Sewage Treatment Plant, died April 2nd after a heart attack. Mr. McNamee had served as chemist at the District plant and was appointed assistant superintendent in 1949. He was 46 years of age.

Mr. McNamee was born at Steelton, Pa.; received his B.S. degree at Dickinson College, in 1927; and his M.S. in chemistry from George Washington Univ., in 1928. He was a member of the A.C.S., the F.S. & I.W.A., the Md.-Del. Water and Sewerage Assn., and the Washington Sanitation Conference; he was active in Boy Scout and Civil Defense work.

Dunstan Now Prof. San. Engineering at Washington State

Positions Available To Graduate Students

Prof. E. B. Moore, Chairman Civil Engineering Department, State College of Washington at Pullman, Wash., announces the addition of G. H. Dunstan to the staff of teachers as Professor of Sanitary Engineering.

Professor Dunstan, holder of degrees from the University of Southern California, Iowa State, and with graduate work at the University of Michigan to his credit, has taught Sanitary Engineering at Iowa State, University of Southern California, Tulane University, and University of Alabama. He is a member of numerous honorary and professional societies, and has had experience with the U.S. Public Health Service. He is at present co-chairman of the Sanitary Engineering Conference and has headed other such conferences.

Professor Moore, at the same time, announces that Washington State has four positions as research assistants for advanced students with B.S. degrees, who may work towards a M.S. in Sanitary Engineering. These positions will involve half-time service during the academic year at a stipend of $1,200 for the 9½ month period. During the summer months full time positions can be assured at $250 per month, conducting field investigations.

For further information address Prof. Emmett B. Moore, Chairman Department of Civil Engineering, State College of Washington, Pullman, Wash.

Look Out California!

Sharpen Those Spurs New York

In a preferred communication from Leslie A. Jackson, Secretary-Treasurer of the Southwest Section of A.W.W.A. we have it from the "horse's mouth" that at the mid-year meeting of the Southwest Sections Board of Trustees, held on March 17 in Little Rock, Ark., the matter of membership promotion was given the green light and the other "green stuff" needed to make membership promotion the primary objective of the Southwest Section for the coming two years.

In an aside Secretary Jackson had the following to say: "We, in the Southwest, no longer have much concern about passing the New York Section in membership; from here on we will be shooting at our only real rival —the California Section."

This is just another indication of the sort of promotional spirit that built up the Southwest Section by Secretary Jackson and his team of co-workers to the third position in membership amongst the Sections. The question is "can the New York Section sharpen its membership spurs enough to hold its lead over the Southwesterners." If our guess is right it's going to take some tough bronc riding to hold a lead over that Southwest crowd who have taken the bit in their teeth with no mistake.

Relief to Water Utilities Required to Relocate Mains

Incorporated in Amendment to Federal-Aid Act

Senate Bill 2585 is of particular interest to water and sewage works managers who have for sometime chafed, because in the necessary relocation or lowering of water mains and sewers, incident to highway regrading or widening, have had to stand the entire expense of such utility facilities relocation work.

The proposed amendment (S-2585) to the Federal-Aid Highway Act will include in construction and betterments for which Federal-Aid is to be available the cost of relocating and otherwise altering all utility facilities necessary in connection with Federal-Aid Highway Construction or regrading.

The passage of the amendment will mean that the entire expense of such utility facilities relocation or alteration can be paid from those Federal funds available for the entire project. In the case of right-of-way or property damage costs, however, Federal reimbursement to the extent of 50% of such costs would be required.

Even though such relief to water and sewage utilities may be something less than a "full-loaf" benefit, any relief is better than none and in due course the entire expense of highway betterments may be removed from the local utilities now so burdened without reason.

Water Treatment Operating Experiences

At the MacDonald, Pa., Filtration Plant of the West Penn Water Company

by J. W. LAWRENCE, *Manager and* T. M. DOUGLAS, *Chief Operator, West Penn Water Co., MacDonald, Pa.*

J. W. Lawrence

Thos. M. Douglas

THE new water purification plant of the West Penn Water Co. at MacDonald, Pa., was placed in service in March 1947. This plant has four filters, each with a rated capacity of 500,000 gal. per day. Of these filter units, two use anthrafilt as the filtering material, one sand and one sand with a 7-inch topping of anthrafilt. Each filter is equipped with a rotating Palmer Surface Wash unit and all filters are operated by hydraulic valves.

The pumping facilities consist of 1-1,500 gpm. low lift pump, used to pump raw water from the reservoir when storage is low; 1-2600 gpm. wash water pump; 1-1200 gpm. high service pump, 1-400 gpm. high service pump and 700 gal. gpm. high service pump.

The chemical feeding equipment consists of a Wallace & Tiernan Chlorinator adapted for prechlorination, post chlorination or both, and four Omega Dry Feed Machines operated automatically in conjunction with a Builders-Providence Chronoflow Meter. Operating on a 15 second time cycle, the Chronoflow records rate of flow, totals the flow and operates the chemical feeders. The capacity of this meter is 2.0 mgd. At zero rate of flow the recorder reads 0 and the chemical feeders do not feed. At maximum flow the recorder reads 2,000,000 gpd. and chemical feeders operate for 13½ seconds (maximum of a 15 second cycle). After being adjusted to feed a certain quantity of chemical into a definite quantity of water, the chemical feeders will maintain a feed directly in proportion to the rate of flow.

Preliminary preparation of the raw water takes place in the Permutit (Spalding) Precipitator illustrated in Fig. 1. Our unit has a capacity of 1,740 gpm. or 2,500,000 gpd. with a detention period of 60 min. at capacity rate of flow.

The water being treated by this unit comes from a surface supply with an average turbidity of 25 ppm. In periods of heavy run-off, however, turbidities increase and range from 5 to 375 ppm. Total (methyl orange) alkalinity varies from 50 to 145 ppm., total hardness from 94 to over 200 ppm. and pH from 7.2 to 8.4. The iron content is approximately 0.6 ppm. and there is only a trace of manganese.

Precipitator as a Softening Unit

With the exception of about 2 months during the summer of 1949, the Precipitator unit has been used exclusively for softening. The hardness is reduced to 85-100 ppm. This exception was due to a severe algae condition which occurred not in the reservoir but in the Precipitator itself. We finally controlled the condition through the use of alum, with small quantities of carbon and soda-ash. Good coagulation was accomplished, however, only at a very high cost, since alum dosages soared to a high of 10 grains per gal. We believe that the danger of algae growing in the Precipitator could be overcome by covering the tank to prevent the entry of sunlight.

Until several months ago, the softening treatment was accomplished by the use of lime with iron sulphate as a coagulant. This treatment was quite satisfactory until algae growths made their appearance. These growths produced color and turbidity in the effluent. Alum and lime have several times been employed for softening and clarification but never successfully. For proper lime softening of this water, a pH of 9.0 to 9.2 must be maintained and alum is not effective at these high pH values.

Iron Coagulant Economical

During the period from January 1, 1949 to November 19, 1949, the per million gallon cost of chemicals was between $22.00 and $23.00. At present we are employing Ferri-floc as a coagulant and are obtaining a better

Fig. 1—Permutit (Spalding) Precipitator at the MacDonald Plant. This unit has a capacity of 2.5 mgd. with a detention of 60 min.

This paper, presented before the Penna. Water Operators Ass'n at State College, Pa., has been released for publication in *Water and Sewage Works*.

water at a lower cost. From November 20, 1949 to date, the per million gallon cost of chemicals is approximately $14.00. Ferri-floc and lime have been used exclusively during this period with an occasional application of carbon. These costs do not include chlorine or copper sulphate.

Precipitated floc and sludge definitely aid coagulation and softening in this type of equipment. Probably the best proof for this statement is the operating difficulties encountered for 3 to 5 days after cleaning. Upon resuming operations, there is carried onto the filters a considerable amount of floc and the turbidity runs from 20 to 30 ppm. In the next 3 to 5 days, a new sludge blanket forms and the turbidity drops to approximately 2 ppm.

In effect, then, the sludge blanket is actually a filter. As the water and precipitate pass from the mixing zone and move upward through the existing sludge blanket, the blanket filters out the sludge particles. When these particles become too heavy to be suspended by the upward velocity, they drop back into the concentrator ring from which they are drawn off by means of the automatic draw-off system.

As stated previously, the capacity of this basin is 1,740 gpm. with a 60-min. total detention period. During a short period, the flow through the basin varies from a maximum of 1,350 gpm. to a minimum of 480 gpm. with a detention period for these rates of 1 hr. 17 min., and 3 hr. 35 min., respectively. Operating at these varying rates of flow, or constantly at either rate, the basin operates equally well. Recent experience indicates, however, that a longer detention period is apparently not practical. While operating at 380 gpm., a higher coagulant dosage was required and, even then, the effluent was inferior, the turbidity rising from 2 ppm. to 6 ppm. The detention period at this time was 4 hrs. 35 minutes.

Safety Factors in Operation

Althought we have operated this basin at only 80 per cent of designed capacity, it is felt that the factors of safety are adequate. Through the use of the automatic or manual draw-off system, the sludge blanket can be carried at a fairly uniform level. Of course, operating at our varying rate of flow, it is desirable to carry the sludge blanket at a lower level in order to insure a greater factor of safety. If the rate of flow is constant, however, the sludge level may be carried higher without danger of effecting the effluent turbidity. In addition to the sludge draw-off system, the 4-speed mixer agitator also provides a measure of safety. Aside from its duty of mixing, it also, along with the upward flow of water, helps to hold the sludge blanket in suspension. By regulating the agitator speed, the sludge blanket may be raised or lowered as desired.

Fig. 2—Sludge collected on Precipitator wall after one year of operation.

This plant, with the exception of one occasion, has never had a taste or odor problem. This exception took place in the summer of 1951 at the time when algae was growing in the mixing basin. At this time, the basin was cleaned; Fig. 2 shows the collection of sludge on the side wall of the unit. Normally, through the use of the draw-off system, the sludge in the basin is kept fresh and active; however, when slight tastes and odors are encountered, the application of carbon is successful in correcting this.

Fig. 3—View of sludge blanket through 3.5 feet of clear water. Normal turbidity is 1 to 3 ppm.

Pre-chlorination of the influent to the basin was carried on for a while but had no effect on the treatment as the chlorine demand of the sludge blanket was very high. The residual chlorine content in the influent was higher than our testing equipment would measure and the residual chlorine content of the effluent was zero.

Interruptions of chemical feed for short periods have little or no effect on the performance of the unit, but any interruption for a prolonged period causes improper coagulation with increased turbidity of the effluent. The ability of the unit to cope with interruptions depends largely on the detention period in the basin at the time of interruption. At the highest rate at which the plant operates—1350 gpm.—the amount of carry-over is negligible. Barring any operating difficulties, the turbidity carried on our filters normally is 1 to 3 ppm. See illustration, Fig. 3. For several weeks, as an experiment, all filters have been operating 168 hours before washing. Our loss of head during the period was less than 2.5 feet in the anthrafilt filters, 4.6 feet in the sand filter and 3.0 feet in the combination sand and anthrafilt filter.

The water level in the Precipitator is controlled by a diaphragm valve which, in turn, is operated by water pressure from a small pilot valve. This operation is such that the influent rate is constantly changing. When the plant is pumping at 1,000 gpm. the rate of flow through the basin varies from 1,350 gpm. to 480 gpm., then returns to 1,350 gpm. within a 20 or 30 minute period. This is quite a variation, but the Precipitator absorbs the shock with ease,

the effluent turbidity remaining constant. The same holds true when the plant is pumping at the rate of 480 gpm. During these periods, the rate of flow through the Precipitator varies from 1,000 gpm. to 140 gpm., and returns to 1,000 gpm. every 20 or 30 minutes. The only effect these sudden changes seem to have is a slight variation on the level of the sludge blanket.

Although our raw water characteristics remain fairly constant, there are times when a heavy run-off causes rapid changes in turbidity and alkalinity. Since we have sufficient warning of the change, it is possible to handle these variations without too much difficulty. Usually, a reduction of lime and an increase in the coagulant is necessary. During these periods, the Precipitator effluent turbidity may reach a maximum of 5 or 6 ppm. When a condition such as this presents itself, proper operation of the equipment depends on the alertness of the operator.

It might be of interest to point out that the Precipitator was installed at this plant as an experiment. In our opinion, it has been demonstrated to be a successful and economical installation.

Some Pointers on Bearings and Couplings*

A correspondent recently asked for advice on the use of anti-friction bearings in preference to plain bearings. He also inquired about the use of flexible couplings.

Bearings on important drives need not necessarily be ball bearings or even anti-friction type bearings. But, where there is more or less flexibility the bearings should certainly be self-aligning. And if there is need for a flexible coupling—as there often is—by all means use one of first class design. A combination of that kind, properly installed, will maintain a high efficiency under all normal deflections and loads. Even under abnormal conditions it will usually do surprisingly well.

It is absurd to use ball or roller bearings on *every* bearing, simply because such bearings run more easily than other bearings. For greatest economy shafts that are used only occasionally should usually be run in plain bearings.

If the power is turned on frequently, even though not continuously, and if electric motors are used for driving, ball or roller bearings may be better than plain bearings because the starting friction of plain bearings is high. On the other hand the starting friction of roller and ball bearings is not much greater than is the running friction. Hence smaller and less expensive motors may frequently be used if the bearings are ball or roller bearings. That, of course, is an important advantage in favor of the anti-friction type of bearing.

Where plain bearings can be kept in good condition, at all times, the cost of the greater frictional load as compared with the more expensive ball or roller bearings is often a very small item and may be ignored. For example, the frictional cost of running the main bearings of an engine, generator, motor, turbine, pump, and similar large units is ordinarily very small as compared with the total power involved, whereas the difference in cost between ball bearings and plain bearings is high. Under such circumstances, therefore, plain bearings may be overall more economical, even though slightly less efficient. The interest on the difference in cost may be greater than the difference in value of the respective losses.

On line shafting lubrication may be comparatively more difficult, and the difference in friction may be considerable and the cost of power considerably less with ball or roller bearings. Under such circumstances it is generally advisable to use the anti-friction type bearings. An important advantage possessed by roller and ball bearings is that they require less lubricant than the plain type and, also, that they needn't be lubricated so frequently.

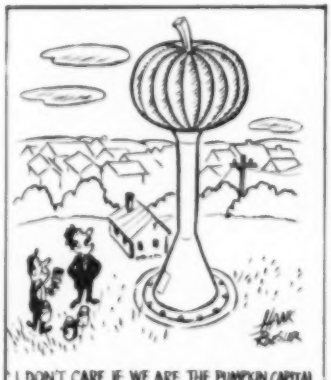
*Contributed by W. F. Schaphorst, M.E., Newark, N.J.

Tax Benefits Should Advance Pollution Abatement by Industry

We are very much interested in the increasing advocacy of some form of tax relief to industrial plants that are facing the necessity of providing pollution abatement facilities which will add to unit costs of production without the benefits of price mark-ups to defray such increased costs of production.

What appears to be a sound and logical proposal to congressional committees is that of short term write-offs of the expenditures for pollution abatement facilities provided by industry to improve water quality at no direct benefit to any but down stream interests. In providing facilities needed in the national defense program the Internal Revenue Department permits a write-off that depreciates the required plant or added facilities for defense production in a period of five years, or even less in some instances.

It would seem that great incentive to industry to go along wholeheartedly, without recourse to so-called legalistic rights or other measures which slow down pollution abatement, would be an Act of Congress which will permit the same pattern of tax relief through short-term depreciation of pollution abatement facilities as is already permissive in the case of national defense facilities.



But, "Commish," I don't think the fellows from the Chamber of Commerce who brought me the paint will like it.

Julian Hinds Retires

As Gen'l. Mgr. M.W.D. of So. Calif.

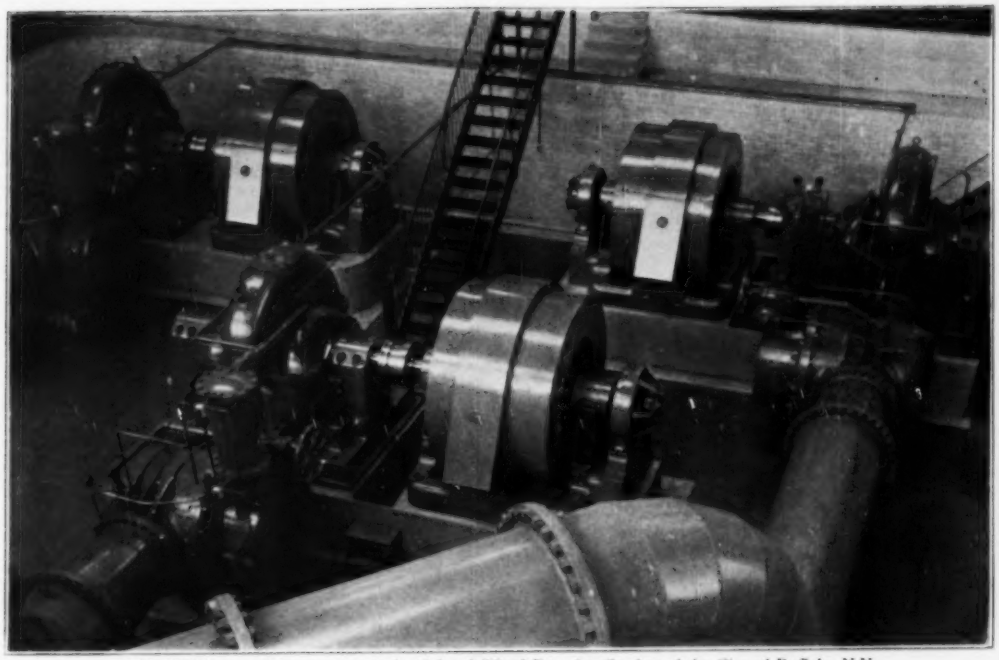
Julian Hinds, long-time General Manager and Chief Engineer of the Metropolitan Water District of Southern California, has retired. Robert B. Diemer, of his staff, has been appointed as Mr. Hinds' successor.

Does It Affect You the Same Way?

Boss: Why do I pay my income tax all at one time?

New Secy.: Yes, you know that you can pay one quarter of it every three months.

Boss: Young lady, I'm just as aware of that as are you; but, I have a fear that my heart could never stand it four times a year.



G.E. 2500-hp. synchronous motors in Colonel Ward Pumping Station of the City of Buffalo, N.Y.

Power Factor Economy with Synchronous Motors

A Means of Extending Capacity of Power Systems in Water and Sewage Pumping Stations

by J. C. MOORE, *Large Motor and Generator Dept., General Electric Co., Schenectady, N. Y.*

Synchronous motors have a broad field of application in water and sewage pumping because of several unique advantages they offer. The fact that they can be obtained in very low speeds makes them well adapted to driving large slow-speed pumps. Then, in ratings (1) above 700 hp. at speeds ranging from 514 to 1200 r.p.m., and (2) above 300 hp. at speeds of 450 r.p.m. and lower, synchronous motors entail a lower initial investment than other types of motors.

In addition, the inherent high efficiency of synchronous motors can result in large savings in power costs over a period of a year where they drive pumps which are required to be in operation day in and day out.

Another important feature of synchronous motors is that their starting characteristics can be tailored to match the pump torque requiremens. This is true because the motor operates on two different principles while starting and running, and the starting characteristics can be designed to cover a wide range of pump and power system requirements without affecting the running characteristics of the motor. This makes it posisble to realize the advantages of full-voltage starting and enjoy the savings of less complicated control in many of the larger ratings where it is not possible with other types of motors.

IN these days of rapidly expanding production, with the consequent upswing in the installation of plant production machinery, many plant engineers are concerned about increasing the load on power systems that already are loaded almost to capacity. Others are contemplating the addition of new power systems where existing systems obviously cannot handle an expanding load.

In either case, high plant power factors are of prime importance, because the load which any power system will carry is proportional to the plant power factor, which is expressed as KW load divided by the KVA load. The efficiency of the whole plant power system increases as the power factor approaches unity. A higher power factor may make it possible to safely increase the hp. load on an existing system. It can also mean less investment in transformers, feeder lines, and voltage regulating devices where a new system is required.

Table I

KW MULTIPLIERS FOR DETERMINING KILOVARS REQUIRED FOR POWER-FACTOR IMPROVEMENT.

Original Power Factor (cos θ_1)	Desired Improved Power Factor (cos θ_2)																			
	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.0
0.50	0.982	1.008	1.034	1.060	1.086	1.112	1.139	1.165	1.192	1.220	1.248	1.276	1.306	1.337	1.369	1.403	1.440	1.481	1.529	1.589	1.732
0.51	0.937	0.962	0.989	1.015	1.041	1.067	1.094	1.120	1.147	1.175	1.203	1.231	1.261	1.292	1.324	1.358	1.395	1.436	1.484	1.544	1.687
0.52	0.893	0.919	0.945	0.971	0.997	1.023	1.050	1.076	1.103	1.131	1.159	1.187	1.217	1.248	1.280	1.314	1.351	1.392	1.440	1.500	1.643
0.53	0.850	0.876	0.902	0.928	0.954	0.980	1.007	1.033	1.060	1.088	1.116	1.144	1.174	1.205	1.237	1.271	1.308	1.349	1.397	1.457	1.600
0.54	0.809	0.835	0.861	0.887	0.913	0.939	0.966	0.992	1.019	1.047	1.075	1.103	1.133	1.164	1.196	1.230	1.267	1.308	1.356	1.416	1.559
0.55	0.769	0.795	0.821	0.847	0.873	0.899	0.926	0.952	0.979	1.007	1.035	1.063	1.093	1.124	1.156	1.190	1.227	1.269	1.316	1.376	1.519
0.56	0.730	0.756	0.782	0.808	0.834	0.860	0.887	0.913	0.940	0.968	0.996	1.024	1.054	1.085	1.117	1.151	1.188	1.229	1.277	1.337	1.480
0.57	0.692	0.718	0.744	0.770	0.796	0.822	0.849	0.875	0.902	0.930	0.958	0.986	1.016	1.047	1.079	1.113	1.150	1.191	1.239	1.299	1.442
0.58	0.655	0.681	0.707	0.733	0.759	0.785	0.812	0.838	0.865	0.893	0.921	0.949	0.979	1.010	1.042	1.076	1.113	1.154	1.202	1.262	1.405
0.59	0.619	0.645	0.671	0.697	0.723	0.749	0.776	0.802	0.829	0.857	0.885	0.913	0.943	0.974	1.006	1.040	1.077	1.118	1.166	1.226	1.369
0.60	0.583	0.609	0.635	0.661	0.687	0.713	0.740	0.766	0.793	0.821	0.849	0.877	0.907	0.938	0.970	1.004	1.041	1.082	1.130	1.190	1.333
0.61	0.549	0.575	0.601	0.627	0.653	0.679	0.706	0.732	0.759	0.787	0.815	0.843	0.873	0.904	0.936	0.970	1.007	1.048	1.096	1.156	1.299
0.62	0.516	0.542	0.568	0.594	0.620	0.646	0.673	0.699	0.726	0.754	0.782	0.810	0.840	0.871	0.903	0.937	0.974	1.015	1.063	1.123	1.266
0.63	0.483	0.509	0.535	0.561	0.587	0.613	0.640	0.666	0.693	0.721	0.749	0.777	0.807	0.838	0.870	0.904	0.941	0.982	1.030	1.090	1.233
0.64	0.451	0.476	0.503	0.529	0.555	0.581	0.608	0.634	0.661	0.689	0.717	0.745	0.775	0.806	0.838	0.872	0.909	0.950	0.998	1.058	1.201
0.65	0.419	0.445	0.471	0.497	0.523	0.549	0.576	0.602	0.629	0.657	0.685	0.713	0.743	0.774	0.806	0.840	0.877	0.918	0.966	1.026	1.169
0.66	0.388	0.414	0.440	0.466	0.492	0.518	0.545	0.571	0.598	0.626	0.654	0.682	0.712	0.743	0.775	0.809	0.846	0.887	0.935	0.995	1.138
0.67	0.358	0.384	0.410	0.436	0.462	0.488	0.515	0.541	0.568	0.596	0.624	0.652	0.682	0.713	0.745	0.779	0.816	0.857	0.905	0.966	1.108
0.68	0.328	0.354	0.380	0.406	0.432	0.458	0.485	0.511	0.538	0.566	0.594	0.622	0.652	0.683	0.715	0.749	0.786	0.827	0.875	0.935	1.078
0.69	0.299	0.325	0.351	0.377	0.403	0.429	0.456	0.482	0.509	0.537	0.565	0.593	0.623	0.654	0.686	0.720	0.757	0.798	0.846	0.906	1.049
0.70	0.270	0.296	0.322	0.348	0.374	0.400	0.427	0.453	0.480	0.508	0.536	0.564	0.594	0.625	0.657	0.691	0.728	0.769	0.817	0.877	1.020
0.71	0.242	0.268	0.294	0.320	0.346	0.372	0.399	0.425	0.452	0.480	0.508	0.536	0.566	0.597	0.629	0.663	0.700	0.741	0.789	0.849	0.992
0.72	0.214	0.240	0.266	0.292	0.318	0.344	0.371	0.397	0.424	0.452	0.480	0.508	0.538	0.569	0.601	0.635	0.672	0.713	0.761	0.821	0.964
0.73	0.186	0.212	0.238	0.264	0.290	0.316	0.343	0.369	0.396	0.424	0.452	0.480	0.510	0.541	0.573	0.607	0.644	0.685	0.733	0.793	0.936
0.74	0.159	0.185	0.211	0.0237	0.263	0.289	0.316	0.342	0.369	0.397	0.425	0.453	0.483	0.514	0.546	0.580	0.617	0.658	0.706	0.766	0.909
0.75	0.132	0.158	0.184	0.210	0.236	0.262	0.289	0.315	0.342	0.370	0.398	0.426	0.456	0.487	0.519	0.553	0.590	0.631	0.679	0.739	0.882
0.76	0.105	0.131	0.157	0.183	0.209	0.235	0.262	0.288	0.315	0.343	0.371	0.399	0.429	0.460	0.492	0.526	0.563	0.604	0.652	0.712	0.855
0.77	0.079	0.105	0.131	0.157	0.183	0.209	0.236	0.262	0.289	0.317	0.345	0.373	0.403	0.434	0.466	0.500	0.537	0.578	0.626	0.686	0.829
0.78	0.052	0.078	0.104	0.130	0.156	0.182	0.209	0.235	0.262	0.290	0.318	0.346	0.376	0.407	0.439	0.473	0.510	0.551	0.599	0.659	0.803
0.79	0.026	0.052	0.078	0.104	0.130	0.156	0.183	0.209	0.236	0.264	0.292	0.320	0.350	0.381	0.413	0.447	0.484	0.525	0.573	0.633	0.776
0.80	0.000	0.026	0.052	0.078	0.104	0.130	0.157	0.183	0.210	0.238	0.266	0.294	0.324	0.355	0.387	0.421	0.458	0.499	0.547	0.606	0.750
0.81		0.000	0.026	0.052	0.078	0.104	0.131	0.157	0.184	0.212	0.240	0.268	0.298	0.329	0.361	0.395	0.432	0.473	0.521	0.581	0.724
0.82			0.000	0.026	0.052	0.078	0.105	0.131	0.158	0.186	0.214	0.242	0.272	0.303	0.335	0.369	0.406	0.447	0.495	0.555	0.698
0.83				0.000	0.026	0.052	0.079	0.105	0.132	0.160	0.188	0.216	0.246	0.277	0.309	0.343	0.380	0.421	0.469	0.529	0.672
0.84					0.000	0.026	0.053	0.079	0.106	0.134	0.162	0.190	0.220	0.251	0.283	0.317	0.354	0.395	0.443	0.503	0.646
0.85						0.000	0.027	0.053	0.080	0.108	0.136	0.164	0.194	0.225	0.257	0.291	0.328	0.369	0.417	0.477	0.620
0.86							0.000	0.026	0.053	0.081	0.109	0.137	0.167	0.198	0.230	0.264	0.301	0.342	0.390	0.450	0.593
0.87								0.000	0.027	0.055	0.083	0.111	0.141	0.172	0.204	0.238	0.275	0.316	0.364	0.424	0.567
0.88									0.000	0.028	0.056	0.084	0.114	0.145	0.177	0.211	0.248	0.289	0.337	0.397	0.540
0.89										0.000	0.028	0.056	0.086	0.117	0.149	0.183	0.220	0.261	0.309	0.369	0.512
0.90											0.000	0.028	0.058	0.089	0.121	0.155	0.192	0.233	0.281	0.341	0.484
0.91												0.000	0.030	0.061	0.093	0.127	0.164	0.205	0.253	0.313	0.456
0.92													0.000	0.031	0.063	0.097	0.134	0.175	0.223	0.283	0.426
0.93														0.000	0.032	0.066	0.103	0.144	0.192	0.252	0.395
0.94															0.000	0.034	0.071	0.112	0.160	0.220	0.363
0.95																0.000	0.037	0.079	0.126	0.186	0.329
0.96																	0.000	0.041	0.089	0.149	0.292
0.97																		0.000	0.048	0.108	0.251
0.98																			0.000	0.060	0.203
0.99																				0.000	0.143
																					0.000

Example: Plant has input of 200 kw at a power factor of 80 per cent. To find the reactive kva required to raise the plant power factor to a desired 95 per cent, multiply the 200 kw by the factor found in the table under 95 per cent opposite the original power factor of 80 per cent, or 0.421. Kvar required, therefore, is 200 x 0.421 or 84.2 kvar.

Good operating conditions require high power factors, too. A poor power factor often results in voltage drops which increase the slip of induction motors to the point where production is adversely affected. If the voltage drops more than 10 per cent below normal, it is quite possible for induction motors to become overheated or stall. High power system losses, poor plant lighting, high power bills, and increased maintenance of the power supply commonly accompany a poor power factor.

In most power systems, a poor power factor is caused by excessive demands for magnetizing current (reactive kva) by induction motors at part loads, transformers, electric furnaces, electric welders, and other inductive equipment. This magnetizing current although necessary does no useful work, of course, and limits the power which a system can carry.

When a new motor drive (75 hp. or larger) is needed in a plant, the installation of a synchronous motor can economically improve a plant power factor. A unity power factor synchronous motor (current in phase with the voltage) accomplishes this by adding to the kw load on a power system without increasing the reactive kva load, since it needs no magnetizing current to operate when normally excited at full load. In other words, it brings closer to 1 the ratio

$$\frac{\text{kw}}{\text{kva}}$$

For example, if a 1000-hp. unity power factor synchronous motor is added to a 1000-hp. plant load having a power factor of .80, the new load of 2000 hp. would have a power factor of .935.

A leading power factor synchronous motor (current leading the voltage) improves plant power factor because it acts as a kilovar generator, and can supply fairly large amounts

of kilovars to a power system while performing its usual driving duties.

The ability of either unit power factor or 0.8 power factor synchronous motors to improve power factor is a function of load and excitation. Decreasing the mechanical load without changing the field excitation increases the reactive kva output of the motor. Fig. 1 shows the reactive kva that two typical synchronous motors will deliver under various load conditions with normal excitation. It is seldom economical to operate a synchronous motor at part load in order to gain greater power-factor improvement and the motor should never be over-excited for this purpose, as this practice can lead to serious overheating.

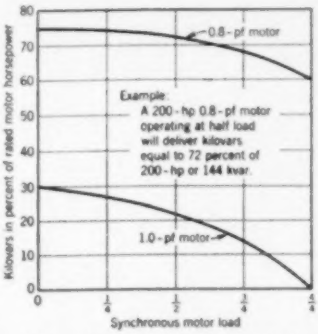


Fig. 1—Reactive kva of two typical synchronous motors under various load conditions with normal excitation.

Another desirable characteristic of the synchronous motor with regard to its effect on the plant power supply is its tendency to stabilize the voltage. Under conditions of high voltage, the reactive kva furnished by a synchronous motor decreases, and under conditions of low voltage within reasonable limits, it increases. The motor, therefore, has a tendency to hold a constant voltage in the power supply.

Furthermore, synchronous motors usually have a higher *full-load* efficiency than any other type of motor, and produce a greater amount of work per dollar's worth of power consumed. Where loads are heavy and continuous, an advantage of from 0.5 to 3.0 percent in efficiency saves a considerable sum in operating expense, and leaves more power available for other plant equipment. At reduced loads, the difference becomes greater to a marked degree, for an efficiency of 75 percent at 5 prcent load has been attained in a synchronous motor.

Whether or not a synchronous motor should be installed for power factor correction depends upon several factors. A careful study might reveal that the particular plant and application lend themselves better to induction motors and capacitors under certain conditions. The total cost, total load, present power factor, and amount of power factor improvement desired all have a bearing on the type of apparatus best suited for improving the power factor. And the provisions made for obtaining a high power factor in a brand new plant are likely to be quite different from those feasible in an existing plant.

Table I is a tabulation of multipliers which may be used to determine the number of kilovars required to improve a power factor by given degrees. Table II shows the kilovars generated by synchronous motors per kw input at various power factors. These tables may be used together to determine the approximate size of synchronous motors which would be needed to accomplish a required power factor improvement.

Other Desirable Characteristics of the Synchronous Motor

Besides their ability to improve the efficiency of plant power systems, synchronous motors have other desirable characteristics which make them especially suitable for many kinds of large motor drives. Some of these are:

1. They may be obtained at very low speeds, thus eliminating or reducing the need for speed-reducing gears.

2. The construction of low-speed synchronous motors results in a saving in space along the shaft when the motor is to be overhung or built into the driven machine.

3. Split rotor construction is optional in low-speed types, which facilitates assembly on shaft of driven machines.

4. Low maintenance costs are the result of inherently simple construction which leaves all parts accessible.

5. In ratings where the hp. is equal to or greater than the speed, they have a lower first cost, including control and exciter, than any other a-c motor with its control.

6. A wide range of torques is available to make possible starting under heavy loads.

7. Dynamic braking brings heavy loads to a smooth, quick stop.

8. Since they run at an exact rated speed, they insure a constant rate of production in constant-speed applications. This constant-speed feature is not affected by voltage changes.

9. They have an inherently large air gap, making field assembly and maintenance easy and economical.

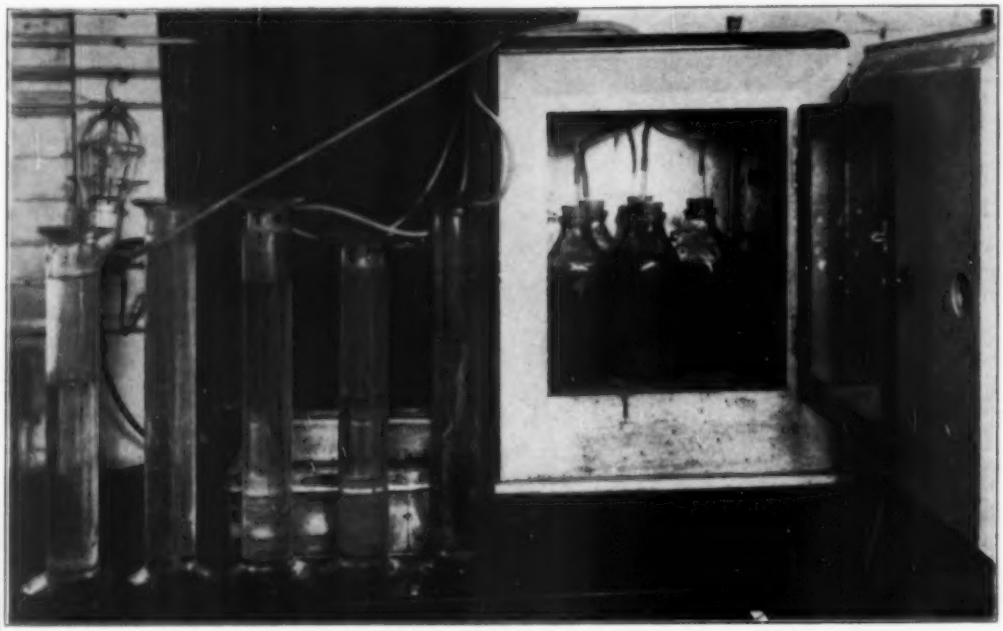
The combined economic and operating advantages of synchronous motors make their consideration worthwhile where any plant requires a new large motor drive. In many instances the installation of synchronous motors is the most economical method of improving plant power factor when their ability to provide efficient mechanical power at the same time is considered.

Table II

Leading Reactive Kva per Kw Input for Synchronous Motors.

Pf.	Kvar	Pf.	Kvar	Pf.	Kvar
1.00	.000	.83	.672	.66	1.138
.99	.142	.82	.698	.65	1.169
.98	.203	.81	.724	.64	1.201
.97	.251	.80	.750	.63	1.233
.96	.292	.79	.776	.62	1.266
.95	.329	.78	.802	.61	1.299
.94	.363	.77	.829	.60	1.333
.93	.395	.76	.855	.59	1.368
.92	.426	.75	.882	.58	1.405
.91	.456	.74	.909	.57	1.442
.90	.482	.73	.936	.56	1.479
.89	.513	.72	.964	.55	1.508
.88	.540	.71	.992	.54	1.559
.87	.567	.70	1.020	.53	1.600
.86	.593	.69	1.049	.52	1.643
.85	.620	.68	1.078	.51	1.687
.84	.646	.67	1.108	.50	1.732

Example: to find horsepower rating of 0.8 power factor synchronous motor required to furnish the 84.2 kvar determined by Fig. 2. Table shows an 0.8 power factor synchronous motor furnishes 0.75 kvar per kw input. The 84.2 kvar required divided by 0.75 equals 112.3 kw. Converting this value to approximate horsepower (neglect motor efficiency and divide by .746), we see that a 150-hp motor at 0.8 power factor would be recommended.



LABORATORY UNITS for septic tank studies—gas collectors, digesters, and incubator.

Tree Roots, Copper Sulfate and Septic Tanks

Copper Sulfate, Applied for Root Control, Should Not Upset Septic Tank Operation

by DON E. BLOODGOOD, *Professor of Sanitary Engineering, Purdue University, Lafayette, Ind.*

TREE roots growing close to sewer lines often penetrate and clog the sewer, creating a troublesome maintenance problem. Wisely[1] said that root stoppages in sewers were more prevalent than obstructions caused in any other way. Even when sewers have been constructed in an approved manner[2] there is some possibility that, after long usage, openings may develop through which roots may enter. It is very desirable to have some method to control the growth of roots that penetrate and clog or tend to clog a sewer.

McAmis reported the successful use of copper sulfate for root growth control in 1933, and his report was reprinted in 1947[3]. A search of the literature did not disclose any data which indicated that the use of copper sulfate had interfered with operation of biological sewage treatment plants. The toxic effect of copper on algae has been appreciated for some time. One of the approved methods for the control of algae growth in water is the addition of copper sulfate to storage reservoirs. There is reason to believe that copper may have a toxic effect upon bacteria because *Standard Methods for the Examination of Water and Sewage* states that B.O.D. dilution water must contain less than 0.01 ppm. of copper.

The available information indicates that root growths in sewers can be controlled by the use of copper sulfate and that applications of this chemical are not known to be detrimental to the operation of municipal sewage treatment plants. There are, however, many indications that copper is toxic to plants and micro-organisms. The question naturally arises as to whether the application of copper sulfate to house sewers, where septic tanks serve as the disposal system, are detrimental to the organisms in the septic tank. Estimates[4] indicate that there are probably about 4,400,000 septic tanks in the United States; these serve at least 17,000,000 people or about 40 per cent of the number of people served by municipal sewage treatment plants.

It would seem advisable and of some importance to know whether dosages of copper sulfate for root control seriously interfere with the operation of septic tanks. To assist in answering this question, experiments were carried out to determine the effect of copper sulfate dosages on sludge digestion, the biological process utilized in the septic tank.

It was impossible to carry out tests on septic tanks using controlled conditions which could be maintained in

Table I

Operation Data For Test Units

	Unit Number 8 lb. rate 1	6 lb. rate 2	4 lb. rate 3	2 lb. rate 4	Control 5
Digested Sludge and Primary Sludge at Start, grams	21	21	21	21	21
Primary Sludge Added in Seven Feedings, grams	27	27	27	27	27
Total Sludge at Start and Added, grams	48	48	48	48	48
$CuSO_4 \cdot 5H_2O$ Added, grams	2.56	1.92	1.28	0.64	0.00
Sludge Remaining in Units after 136 days, grams	26	25	27	30	27
Solids lost, grams	22	23	21	18	21
Ash in Remaining Sludge, per cent	52	55	51	53	53
Gas Produced After Copper Sulfate Addition, cc.	5,757	9,950	12,100	12,835	12,860
Gas Produced Entire Period, 136 days, cc.	8,737	12,845	15,015	15,700	15,505
Depth of Sludge in Each Unit after 136 days, inches	3½	3⅜	3⅛	3⅜	4⅛

laboratory tests. The conditions for laboratory testing were designed to be in proportion to septic tanks of 300 gallons capacity, in the belief that this would be the smallest septic tank to be approved for any installation. It was considered that the maximum dosage of copper sulfate ($CuSO_4 \cdot 5H_2O$) which might be placed in a sewer discharging to a 300 gallon septic tank would be eight pounds during any one day. The decision was made to operate four units of laboratory apparatus and to apply copper sulfate ($CuSO_4 \cdot 5H_2O$) at rates corresponding to 2, 4, 6 and 8 pounds per 300 gallon tank. A fifth unit of laboratory apparatus was operated for control purposes. The copper sulfate concentrations applied would be 0, 800, 1600, 2400, and 3600 ppm.

It did not seem advisable to set up laboratory models of septic tanks. The laboratory setup was considered to provide more severe operating conditions than would have been experienced had model septic tanks been flushed out by daily additions of sewage.

The five laboratory model septic tanks or digestion tanks were set up using square quart milk bottles for tanks. Arrangements were made to collect and measure the gas in 500 ml. glass cylinders which were inverted in 1000 ml. cylinders. This apparatus, including the 36° C. incubator in which the tanks were housed, is shown in Fig. 1.

Procedure

A quantity of digested sewage sludge and another of primary sludge was obtained at the Crawfordsville, Indiana, sewage treatment plant. The digested sludge was thoroughly mixed, then an 800 ml. portion was placed in each of the five digestion tanks. To this was added 80 ml. of primary sludge. Remaining primary sludge was stored in a refrigerator to be used for additional feedings. It was believed that digestion activity could be determined by measurements of the gas produced in each unit.

Analyses showed the digested sludge to contain 2.38 per cent total solids and the primary sludge to contain 4.86 per cent total solids.

Within 24 hours after sludges were placed in the digestion units, several foamed so badly that some gas lines were filled with sludge. It was then decided to remove 80 ml. of thoroughly mixed sludge from each unit. For the remainder of the test, approximately 800 ml. of sludge was maintained in each digester.

Operation

The units were studied for 4.5 days and were found to operate identically (as indicated by the gas production figures of 2980, 2895, 2915, 2865 and 2645). Two feedings of primary sludge were made during the period. After this stabilizing period, copper sulfate was added to all units at one time in the amounts previously indicated. The copper sulfate was applied as a solution containing 256 grams $CuSO_4 \cdot 5H_2O$ per liter.

A complete record was maintained of gas production, in order to evaluate biological activity in the several units. Additions of primary sludge were made to a unit whenever it appeared that practically all of the previously added primary sludge had been digested. There were six primary sludge additions after the copper sulfate had been added. Before each feeding, an equal volume of relatively clear supernatant was removed to make room for the feed sludge. The addition of copper sulfate caused the sludge to float in some units. Some units foamed quite badly from time to time. Scum in foaming units was broken up by shaking and was then completely mixed with the liquid.

Table II

pH of Material in Digestion Units

Days After Start of Test	Unit Number 8 lb. rate 1	6 lb. rate 2	4 lb. rate 3	2 lb. rate 4	Control 5
*6	6.55	6.85	6.90	7.10	7.15
9	6.35	6.60	6.90	7.05	7.00
11	6.45	6.70	7.15	7.15	7.18
13	6.00	6.45	7.15	7.15	7.14
16	6.00	6.95	7.24	7.24	7.25
19	6.00	7.10	7.35	7.38	7.44

*The copper sulfate was added on the 5th day.

At the start 19.04 grams of digested sludge solids was added to each unit; to this was added 3.88 grams of primary sludge. Because of the foaming, 80 ml. of the mixture was removed on the second day (a removal of 2.08 grams of solids from each of the digesters if there had been no solids loss in digestion). The units, by calculation, held 20.84 grams of solids. In seven subsequent additions of primary sludge, 27.16 grams of solids were added to each unit. There were 48.00 grams of solids in or added to the units over the 136 days that they were operated. At the end of this period the depth of sludge in each unit was measured, all of the material in each unit was dried down, and the remaining dry solids were weighed. No information was obtained on the amount of solids removed in the relatively clear supernatant that was removed prior to each feeding. Ash determinations were made on the dried solids. The accumulative gas productions for the period after the copper sulfate addition are given in Fig. II. Data relative to the operation of the units is given in Tables I and II.

Hourly rates of gas production were calculated for every half day during the entire 21 days following the copper sulfate addition. The rate of gas production was found to be highest in the first half-day immediately after feeding, with a decrease in rate until the next feeding, as illustrated by the data for the control, presented in Table III.

Only the data showing significant changes in gas production rates is presented in Table IV.

Discussion of Data

From Table I it appears that practically the same amount of solids remained in each unit at the end of 136 days of digestion. This indicates the decomposition of solids in all five units had been the same. The ash content of the solids remaining after digestion was comparable in all units, indicating that the organic solids had been decomposed equally in all units regardless of the copper sulfate dosage. However, the quantity of gas produced in the decomposition sludge solids was materially reduced with

Table III

Hourly Rates of Gas Production For The Control

Time Interval	Gas Production cc/hr
1st ½ day after feeding	33.6
2nd ½ day after feeding	32.8
3rd ½ day after feeding	25.6
4th ½ day after feeding	18.9
5th ½ day after feeding	16.9

increased dosages of copper sulfate. Computations based on the data in Table I show that the decrease in gas production is not directly proportional to the quantity of copper sulfate added.

Measurement of sludge volumes at the end of the test showed that the copper sulfate dosages tended to reduce the volume occupied by the settled sludge. The pH of the liquid in the units was decreased by the copper sulfate additions. It is interesting to note that the gas production rates returned to normal at about the time the pH became alkaline.

The unit receiving the two pound copper sulfate dose produced gas at approximately the same rate as the control unit 2.5 days after the copper sulfate was added. The unit receiving the four pound dose of copper sulfate produced gas at approximately the same rate as the control unit 6.5 days after the copper sulfate was added. The unit receiving the six pound dose of copper sulfate produced gas at approximately the same rate as the control unit 15 days after the copper sulfate was added. Sludge feedings were not continued over a sufficiently long period of time to learn whether the unit receiving the eight pound dose of copper sulfate would eventually produce gas at the same rate as the control.

Findings Related to Septic Tank Operation

It is recognized that the laboratory units do not simulate exact conditions which might arise if copper sulfate was added to a septic tank, but it is believed that valuable operating information has been obtained.

Table IV

Data Showing Significant Changes in The Hourly Gas Production Rates

Period of Measurement	Unit Number 8 lb. rate 1	6 lb. rate 2	4 lb. rate 3	2 lb. rate 4	Control 5
Last ½ Day Prior to Copper Sulfate Addition	34.0	27.6	26.4	26.0	25.6
First ½ Day After Copper Sulfate Addition	3.4	9.0	11.3	13.5	18.9
2½ Days After Copper Sulfate Addition	0.2	2.2	20.6	30.8	27.3
6½ Days After Copper Sulfate Addition	5.6	17.2	42.8	45.2	45.6
15 Days After Copper Sulfate Addition	5.9	28.3	29.0	32.3	21.7

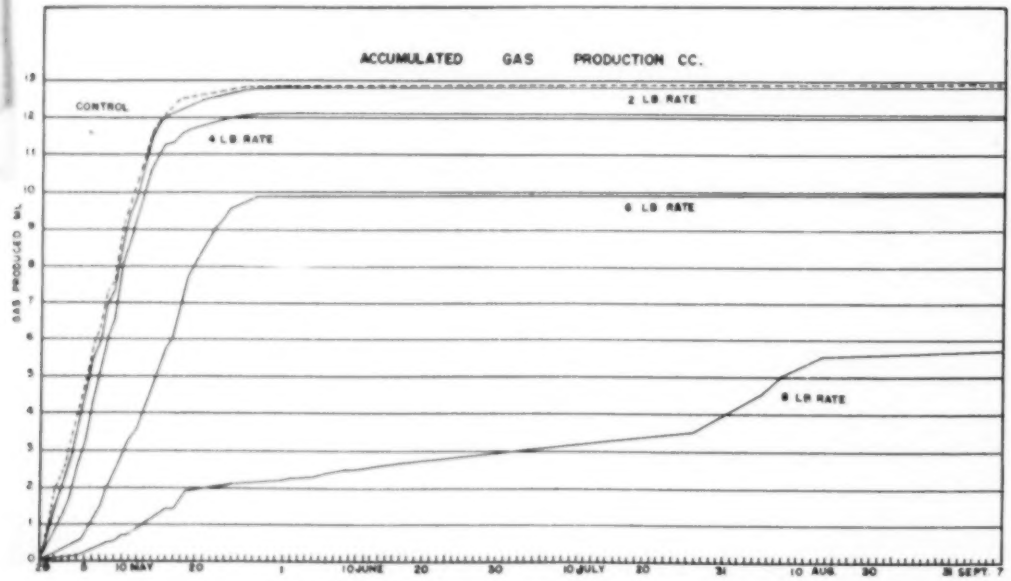
In a septic tank the relation of volume of liquid passing through the tank to the sludge digestion capacity of the tank would be greater than in the experimental units; thus, in a septic tank the soluble copper sulfate would be flushed out sooner than in the test units.

Scum formation, resulting from addition of copper sulfate, might decrease the settling efficiency of the septic tank for a few days; it seems very likely that a properly baffled septic tank would retain the scum and, as soon as the entrained gas was released, the sludge would again settle.

The dosages of copper sulfate at rates of 2, 4, and 6 pounds per 300 gallons do not affect the rate of gas production for longer than 15 days. This period is insignificant as compared to the time that sludge is held in septic tanks between cleanings. Usually septic tanks are not cleaned more often than once every two years.

The indications are that even though the additions of copper sulfate first reduce gas production, they do not bring about any decrease in the amount of organic matter destroyed by digestion in a period of 136 days. The indications are that the carbon may have been lost from the system in a gas containing more carbon per molecule than either carbon dioxide or methane.

No studies were made as to the effect of copper sulfate-containing effluent from a septic tank upon an absorption field. Observations made at the time of adding copper



GAS PRODUCTION in laboratory units after addition of copper sulfate.

sulfate to the experimental units revealed considerable copper to be precipitated as soon as it was added to the sludge; accordingly, much of the added copper might remain in a septic tank as a precipitate mixed with the sludge.

Conclusions

Laboratory experiments demonstrate that a copper sulfate dosage of at least 3,200 ppm. will not interfere with volatile solids reduction in an ordinary septic tank, if the dosage is not applied more often than once every four months. A copper sulfate dosage of 800 ppm. (2 lbs. in a 300 gallon tank) has practically no effect upon production of gas or upon volatile solids reduction in a septic tank.

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Water Pollution in The United States

This booklet, of 44 pages with charts and illustrations is the production of the U.S. Public Health Service. It presents a graphic picture of the stream pollution situation in the United States and means for prevention of further pollution. This booklet is primarily intended to emphasize the existing extent of pollution from municipal and industrial sources and measures for prevention of increasing pollution. As a reference publication "Water Pollution in the U.S." contains many useful and pertinent facts which should interest all citizens desirous of seeing pollution correctives instituted, as well as the sanitary engineering profession at large. Copies at 35 cents (not in stamps) each are obtainable from the Supt. of Documents, Washington (25) D.C. Order publication F.S. 264:1.

Minneapolis Water Users Get Carbon Monoxide Scare

The Minneapolis water works telephone was busy for a full day and department officials denied repeatedly that it could be fatal to drink city water.

A story in a local newspaper, discussing water consumption, mentioned some of the chemicals added to water in the purification process. The story mentioned *carbon dioxide* which, in print, appeared as carbon monoxide. Enough citizens who know carbon monoxide (to put it mildly), won't do anyone any good, became sufficiently concerned to do the telephoning.

A conspicuous correction was printed in the newspaper the following day. It said there is absolutely no carbon monoxide in Minneapolis city water. Positively not.

If your efforts were criticized, you must have done something worth while.

RATIOS

Velocities, Volumes, Capacities, Lengths, Speeds, Time, Flows, Distances, Diameters, Etc. . . . Etc.

Every reader will appreciate this simple and handy "logarithmic line" which does away with much of the pencil figuring commonly indulged in when solving ordinary ratio problems. It is applicable to a surprisingly wide variety of engineering, water and sewage works, and other problems that come up from day to day.

For example, let us say that you find you can lay 7 miles of pipe in 23 days. How long will it take to lay 88 miles of pipe?

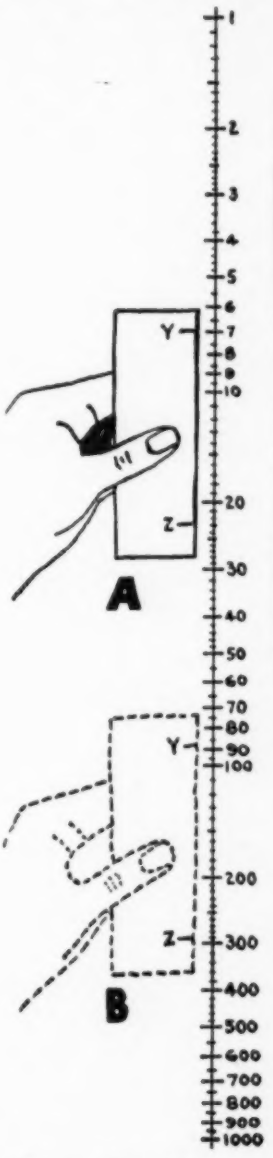
Solution: On a slip of paper in position "A" (see sketch) make a mark opposite the 7 as indicated by the "Y," and then make another mark opposite the 23 as indicated by the "Z." Now move the slip of paper down to position "B" so that "Y" falls opposite the 88 on the scale. The mark "Z" now tells you immediately that you can lay 88 miles in 290 days, and that's the answer.

Do some experimenting with the scale "on your own" and you will quickly catch on. You will then keep it in a convenient place for frequent use in connection with many ratio problems of all types.

Here is a tip: If the figures on this scale are not large enough for you, just add ciphers to all the figures. Thus make it read 10, 20, 30 and so on to 10,000. If the figures still aren't large enough make them read 100, 200, 300, etc., to 100,000—and so on. The "line" will still work for you exactly as explained above. Try it.

[Ed. Note: Many will recognize this useful and simple to use "logarithmic line" as a slide rule on paper. The "slide" is the slip of marked paper.]

A contribution of W. F. Schaphorst, M.E., Newark, N.J.



NJS & IWA in Atlantic City

Report of 37th Annual Meeting

President
Sol Seid
New Brunswick, N.J.
(Incoming)

President
John Struss
North Wildwood, N.J.
(Retiring)

THE thirty-seventh annual meeting of the New Jersey Sewage and Industrial Wastes Association was held in Atlantic City, March 12-14, with a registration of 350 members and guests. A wide variety of technical papers were presented in three sessions, and the last day featured an operators' breakfast, symposium and business meeting.

W. H. WISELY, Executive Secretary-Editor of the F S & I W A, was a guest at the meeting and presented a stimulating discussion titled "PUBLIC RELATIONS FROM THE STANDPOINT OF A SEWAGE WORKS OPERATOR." The technical program included two motion pictures: "The Delaware —Water for Millions" and "Pipeline to the Clouds." These excellent films were prepared by The Interstate Commission on the Delaware River Basin, and The General Electric Co., respectively.

The social event of the meeting was the "Speechless Dinner" and the excellent entertainment following it. The exhibits of 18 manufacturers were well displayed in conjunction with the meeting.

New Officers

New officers elected to serve for the coming year are:

President—Sol Seid, Supervisor, Dept. of Public Works, New Brunswick, N.J.

First Vice-Pres.—John W. Hood, Supt., Sewage Treatment Plant, Ridgewood, N.J.

Second Vice-Pres.—John Collom, Supt., Sewage Treatment Plant, Bordentown, N.J.

Secretary-Treasurer—M. S. Kachorsky, Supt. of Public Works, Manville, N.J.

Executive Committee Members

L. J. Fontenelli, Superv. Engr., Rahway Valley Joint Meeting Plant.

A. J. Macri, Oper. Treatment Plant, Hammonton, N.J.

R. S. Shaw, Bur. Engrg., State Dept. Health, Trenton, N.J.

Technical Program

Moderators of the four technical sessions were:

John Struss, Retiring President, N J S & I W A, Supt. of Sewage Treatment, North Wildwood.

L. J. Fontenelli, Ch. Engr., Sewage Treatment Plant, Rahway Valley Sewerage Authority.

Sol Seid, First Vice-Pres., N J S & I W A, Superv. New Brunswick Dept. of Pub. Works.

Henry Van Der Vliet, Supt. and Chief Engr., Rutherford Joint Meeting.

The Earth Will Provide

"WOODS IRRIGATION WASHES DISPOSAL OPERATIONS"—*John M. Seabrook*, Executive Vice-Pres., Seabrook Farms Co.

Mr. Seabrook told an exciting story of a new development in waste disposal, one utilizing an unsuspected principle of soil adsorption. By the technique reported, liquid wastes are removed, processed, and returned to nature in an inoffensive manner which creates no pollution of streams or ground water—all at a cost of 3 to 4 cents per ton. This, he pointed out, actually constitutes the use of a natural resource without its abuse.

He reviewed the development of means employed to dispose of liquid wastes from a large and ever-growing frozen food processing operation. Located north of Bridgeton, N.J., wastes from the plant originally were discharged to a small stream, then to lagoons, then to a chain of lakes, then to treatment by screening and chlorination—each of these, in turn, became overloaded and created odor nuisances. Three pilot plants were set up to evaluate treatment methods (high rate filters, low rate filters chemical coagulation), and some 275,000 analytical determinations were made. The plant sanitary wastes are not a problem, as these are separately treated on trickling filters.

Representative
Henry Van Der Vliet
Rutherford, N.J.
(F.S. & IW.A.)

Secy.-Treas.
M. S. Kachorsky
Manville, N.J.
(NJS & IWA)

1st Vice-Pres.
John W. Hood
Supt., Treatment Plant
Ridgewood, N.J.

2nd Vice-Pres.
John Collom
Supt., Treatment Plant
Bordentown, N.J.

The solution arrived at has been to screen and heavily chlorinate the wastes, to deliver them through a long open canal, and to dispose of them by soil adsorption in a unique irrigation project. Pumps are set at intervals in the canal (which serves as a reservoir), and these deliver the waste water through 8-inch mains to irrigation type spray nozzles which operate on a 250 ft. head. Early attempts to dispose of wastes by sprinkling over a cover crop showed that a 2-inch application would be followed by run off. It was discovered, almost by accident, that wooded areas possessed enormously greater adsorption capacity.

Operations now demonstrate that 1000 to 1200 inches of waste water may be applied per year to the most heavily wooded areas of land. There is no odor problem. Infiltration rates of the forested lands has actually increased year by year, and there is no surface run off. Regular measurements are made of water table depth, and samples are taken for analyses, from a number of test wells. Results show that a reduction of B.O.D. has taken place in the ground water over that originally found.

Two full years of operation have demonstrated the low cost and effective disposal through use of this method of irrigation. While operation is simple, Mr. Seabrook emphasized that the design of this system must be care-

fully planned. There are now 19 installations of this type in operation.

C. W. Thornwaite, Director, Laboratory of Climatology, Johns Hopkins Univ., Seabrook, N.J., answered a number of questions based on extensive studies made by his laboratory. He stated the waste irrigation method disposes of water into the earth at a rate about 4 times as high as the rate of the rainiest location on earth.

Little has previously been known of the high adsorption rate characteristic of undisturbed forest areas. The difference between this natural soil and cultivated fields apparently accounts for the difficulty of field irrigation. There is no fly nuisance in the irrigated woods areas. Future potentialities of this disposal method are still unknown.

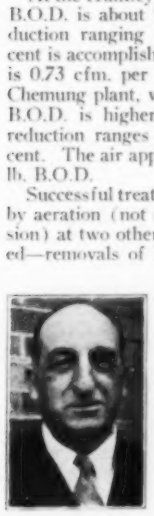
Dairy Waste Treatment

"Aeration—A Successful Treatment of Dairy Waste"—By *G. E. Houer*, chief engineer, and *G. A. Fleet*, New York District Mgr., American Well Works.

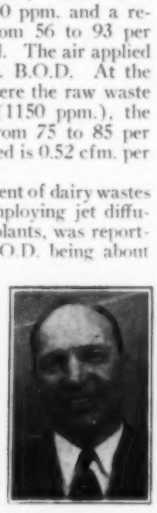
In presenting this paper, Mr. Fleet emphasized the applicability of jet-type aerators in the treatment of dairy wastes—as demonstrated by results obtained in new plants at Huntley and Chemung, Ohio. The method of aeration apparently plays an important role—jets were installed to replace the air diffusion equipment originally installed at Huntley. At Chemung, 22 jets were originally installed, but half of that number has been found adequate.

At the Huntley plant, the raw waste B.O.D. is about 950 ppm. and a reduction ranging from 56 to 93 per cent is accomplished. The air applied is 0.73 cfm. per lb. B.O.D. At the Chemung plant, where the raw waste B.O.D. is higher (1150 ppm.), the reduction ranges from 75 to 85 per cent. The air applied is 0.52 cfm. per lb. B.O.D.

Successful treatment of dairy wastes by aeration (not employing jet diffusion) at two other plants, was reported—removals of B.O.D. being about 96.5 per cent. Air applied in these plants (Germantown and Dayton, Ohio) ranges from 1.8 to 4.08 cfm. per lb. B.O.D. The particular advantage of jet aeration, therefore, appears to be in accomplishing effective treatment using considerably lower air application than would be satisfactory by other means. In general, 0.6 cfm. per pound of B.O.D. may provide sufficient air.



Host
George Cameron
Supt., Atlantic City Sewerage Co.



Natl. Secy.
W. H. Wisely
Champaign, Ill.
FS & IWA

New Plant Problems

"Starting-Up Experiences at Philadelphia"—by *Ralph A. Hoot*, Supt. of Sewage Disposal, Philadelphia, Pa.

The Northeast sewage treatment plant, of modified activated sludge type has utilized all units of the original plant except for the old Imhoff tanks. The remodeled plant has a capacity of 125 mgd. and uses about 0.33 cu. ft. of air per gal. Successful operation is based on maintenance of a low concentration of solids in the mixed liquor (only about twice the concentration of solids in raw sewage).

Foaming in aeration units is a real problem at this plant. Various defoamants have been found effective, but all those investigated are too expensive for regular use. Examination of foam has revealed it to possess a high content of total bacteria and of coliforms.

The various plant units have been placed in operation gradually, and sludge digestion has so far been unsuccessful. It is evident that the sludge heating units must be started before digestion will take place. To date, the final effluent contains about 74 ppm. of suspended solids and the same B.O.D. content; this is a reduction from the raw content of 167 ppm. solids and 136 ppm. B.O.D.

Data on Detergents

"Effects of Detergents on Sewage Treatment Processes" by *R. Manganelli*, Research Associate, Dept. of Sanitation, Rutgers Univ.

The past 10 years has seen a rapid expansion in the use of synthetic detergents: In 1941, there were some 200 brand names—there are now 700. In 1941, production was about 28 million lb.—it is now 1.5 billion lb. In the same period, sales of detergents have increased from 1 per cent to 54 per cent of soap sales. Anionic detergents account for about 90 per cent of the total bulk, and over 40 per cent is of the alkyl sulfonate type.

Studies reported in this paper involved laboratory investigations of anionic, non-ionic, and cationic detergents in relation to sewage treatment processes. In concentrations up to 100 ppm., only the cationic type was found to have any effect on sewage oxidation processes. The effect on chemical coagulation was found to be more marked with low doses of coagulants, but not to be significant with optimum coagulant doses.

Chairmen

H. C. Greenfield
State Dept. Health
(Arrangements)

L. J. Fontenelli
Rahway Valley
(Program)

Cationic detergents have some effect on dispersal of coliform organisms during settling of sewage. Neither the anionic nor non-ionic types affect sewage chlorination, but the effectiveness of chlorination is increased by cationic detergents when contact periods are above 10 minutes. Detergents, due to their resistive effect, may seriously interfere with stream reaeration.

In general, some decrease of aeration efficiency in sewage treatment may be expected to result from the growing use of detergents. Some decrease in gas production may result, and an increase in coagulant dosage may be required. Industrial wastes containing large amounts of specific detergents may cause difficulties in waste treatment.

Foam Can Be Controlled

"Foam Control of Wastes Disposal"—by *W. B. Stevens*, Staff Engr., Socony-Vacuum Oil Co., New York, N.Y.

For several generations, simple defoaming substances such as kerosene have been employed. The increasing severity of foaming problems involving activated sludge, industrial washes, paper mills, etc., has led to the development of more efficient products for the purpose.

The material described by Mr. Stevens has the trade designation TD 709 X. It is a free-flowing, light colored, compounded oil-non-flammable, pour point −23° F., and weighs 7.5 lb. per gal. Named Foamarex W, this product can be simply dripped into the flowing sewage where thorough mixing and dispersion will result; it may be added on the influent side of a centrifugal pump for mixing; or applied in a return sludge line.

Plant scale results from the use of

State Health Dept.

A. H. Fletcher
Director, Bureau of Environmental San.

R. S. Shaw
Dist. Chief Pub. Hl. Engr.

Foamarex W were described (the application may be intermittent or continuous) and lantern slides were shown to illustrate its effectiveness. Analyses of treated effluent, showing an oil content of 27 ppm., indicate the actual increase of oil content due to the anti-foam agent to be only 0.5 to 1.5 ppm.

In discussion from the floor, Wellington Donaldson, New York City, said analyses of foam have indicated its composition to be about one-third to one-half grease.

New Flow Measuring Device

"TYPE S PARABOLIC FLUME FOR SEWAGE MEASUREMENT"—by *Frank Sommer*, Simplex Valve & Meter Co.

Mr. Sommer reviewed briefly the advantages and disadvantages of various types of sewage flow measuring devices. The need for an improved open channel device was obvious—but one simple to install and maintain was required.

The unit developed is a flume having a circular inlet with smooth transition to the paraboli shape, and is of such length as to be self-cleaning. A gage glass indicates the flow rate. It is designed to measure accurately over a wide range where free flow exists, and accurate flow measurement may be obtained over a 20 to 1 range. Applications to municipal, industrial, and process liquids are expected to be numerous.

Prevention Vs. Cure

"RECENT IMPROVEMENTS AT THE PLAINFIELD JOINT MEETING PLANT"—*Andrew Palmer*, Superintendent.

Comprehensive studies of the sewer system and of industrial wastes can be responsible for improved efficiency in operation of plant treatment units. Mr. Palmer described the many additions which have been made, and the experimental studies conducted, at the Plainfield plant which was originally (1916) built as an Imhoff plant.

Expansion took place at intervals, but increases in sewage volume, loading, and industrial waste concentration were always a little greater. Most serious has been the problem of septic sewage due to long flows and overloaded plant units. The quality of raw sewage was improved by correcting conditions at pumping stations or improving quality of industrial wastes through an effective industrial waste ordinance.

Additional units have been added for primary sedimentation, sludge digestion, and sludge conditioning. Construction work has been done by plant labor. Removals accomplished are now 80 per cent for suspended solids and 88 per cent for B.O.D.

Progress Detailed

"ACTIVITIES OF NEW JERSEY IN THE CLEAN-UP OF THE INTERSTATE DELAWARE RIVER"—by *John D. Cohen*, Public Health Engr., for Incodel, N.J. State Dept. Health.

A summary of progress in the pollution abatement of the Interstate Delaware River was presented in Mr. Cohen's paper. Under the Public Health Law, some $17,000 has been allocated to the New Jersey State Dept. Health and $11,000 to Incodel for the work. As a starting point to evaluate the waste problem and its solution (treatment plants) maps have been prepared, 200 industries have been inspected, questionnaires have been completed, and waste sampling and analysis are under way.

Information obtained in investigations has led to reduction in the volume of wastes discharged, industry has programs of better housekeeping, and the State has revised its statutes to incorporate Incodel requirements. Only two communities now discharge raw sewage. The majority of industries utilize municipal sewer systems rather than provide individual treatment.

The zone system (based on water quality requirements) is employed. The State of New Jersey has established minimum zone requirements and bases its standards on waste effluent quality rather than on stream quality.

K. C. Lauster, Sen. San. Engr., U.S.P.H.S., North Atlantic Drainage Basin, in a prepared discussion, highly commended the cooperative attitude existing between Incodel and the State Dept. Health. Comparing conditions and progress in the entire Delaware Basin, he pointed to Incodel as including about 20 per cent of the overall needs, and to already have 42 per cent under construction. The Interstate Delaware basin is progressing about twice as rapidly as the North Atlantic Basin as a whole.

Mr. Lauster considered effluent standards essential, but recognized, as the basic consideration, the effect of an effluent on the receiving stream. Technical and economic questions of waste treatment must be solved in a realistic manner. He questioned the writing of firm and inflexible standards into state laws.

Modified Activated Sludge

"AERO-ACCELATOR-AERO-CYCLATOR"—by *A. A. Kalinske*, Director of Development, Infilco, Inc.

Presenting the Biosorption process as a modified activated sludge method of treatment, Mr. Kalinske cited its advantage as the reduction of initial construction cost. The basic difference involved is in separation of the steps of adsorption and oxidation; if the initial step of adsorption is prolonged, the reductions obtained will not be as high.

The modified process was developed almost simultaneously (and independently) by Hood and Eckenfelder at Ridgewood, N.J., and by Ullrich and Smith at Austin, Texas. After reviewing laboratory, pilot plant, and full scale studies, Mr. Kalinske summarized requirements as: equipment to provide a mixing and aeration period of about 30 min., clarification of 2 hr., and stabilization of 2.5 hr. Adsorption of suspended and coloidal material takes place in the short mixing and aeration period, and no nitrification occurs. The process gives promise of applicability to the treatment of some organic wastes, and operates well for the treatment of raw (unsettled) sewage.

Chlorine Demand Problems

"NOTES AND COMMENTS ON THE CHLORINE DEMAND TEST"—by *Thomas M. Riddick*, Cons. Engr.-Chemist, New York, N.Y.

Mr. Riddick reviewed the chlorine demand test as provided in *Standard Methods for the Examination of Water and Sewage*, and commented on the various interfering reactions involved in the application of chlorine for the purpose of disinfection. As applied to the measurement of the chlorine demand of trade wastes, he

Pollution Abatement

Seth G. Hess
Dir. & Chief Engr. Interstate San. Comm.

K. C. Lauster
Sen. San. Engr. U. S. Pub. Hl. Serv.

pointed out that this is a test of dubious accuracy.

Several lantern slides were used to illustrate the known factor of concentration; i.e., that the chlorine demand varies with the dose applied. Reactions of chlorine in sewage and in industrial wastes may be quite different than those in water, but the chlorine demand test utilized is essentially the same as for that employed to determine the chlorine demand of water. A "healthy skepticism" was advocated in order to make proper use of the chlorine demand test for specific application.

L. L. Hedgepeth, Tech. Consultant, Calco Div., The Amer. Cyanamid Co., Bound Brook, N.J., described the chlorine demand of a waste as a factor which may be extremely important to industry. Engineering methods and judgements based on sanitary experience are not necessarily applicable to industrial waste treatment problems. Depending upon the specific chlorine demand test employed, the indicated chlorine requirement may show wide variation. One industrial waste, for example, appears to require an amount of chlorine costing $175,000 annually, according to one test employed; it appears to require an amount costing $25,000 according to another test.

It is regrettable that a test designed for evaluating sewage characteristics and found not applicable to evaluating industrial wastes should be adhered to. Those who insist on retaining the sewage chlorine demand test for industrial waste evaluation claim it is well established—and that changing the method for a new purpose would invalidate many of the old results based on the original test. Mr. Hedgepeth decried the attitude that new knowledge of industrial wastes must be completely understandable in terms of old sanitary engineering knowledge.

Dr. Donald Tarvin, Chem. Engr., Calco Div., The Amer. Cyanamid Co., commented on extensive investigations of three methods of chlorine demand determination. The results on one industrial waste show wide variations and practically no correlation.

Dr. Willem Rudolfs, Chief, Dept. of Sanitation, Rutgers Univ., emphasized that the actual chlorine demand (in practice) is the amount of chlorine required for disinfection; charges for chlorination should obviously be based on the actual demand. With reference to industrial wastes which would be discharged to the proposed Raritan Valley Sewer Authority, Dr. Rudolfs said preliminary tests showed the combination of 18 industrial and 20 municipal wastes would exhibit a *combined* chlorine demand approximately 20 per cent lower than the total demand of the individual wastes.

Thomas M. Riddick
Cons. Engr.-Chem.
New York City

L. L. Hedgepeth
Tech. Consultant
Amer. Cyanamid Co.

Leslie E. West
Chief Engr.
Elizabeth, N.J.

Ralph A. Hoot
Supt. Plants
Philadelphia, Pa.

Programmers

Formula for Good Relations

"PUBLIC RELATIONS FROM THE STANDPOINT OF A SEWAGE WORKS OPERATOR"—*W. H. Wisely,* Exec. Secy.—Editor, F S & I W A.

Speaking as an ex-plant operator, and one very familiar with the operators' public relations problems, Mr. Wisely presented a formula. The formula is actually a summary of four practical points which can be applied to solving happily the important problem of maintaining good public relations.

The four points emphasized are: 1. A service job well done, including good plant operation and maintenance; 2. Super-courtesy to the public; 3. Favorable publicity; and 4. Participation in outside activities. This formula requires one more item—The catalyst, which is the personal enthusiasm of the individual who wants to make it work.

Barge Disposal of Sludge

"SLUDGE DISPOSAL EXPERIENCES AT THE ELIZABETH JOINT MEETING PLANT"—*Leslie E. West,* Chief Engineer.

During the past 15 years, the Elizabeth Joint Meeting Plant has disposed of 1.25 million tons of sludge—the equivalent of a layer covering 900 acres to a depth of one foot. Mr. West noted that only the Passaic Valley Plant employed sea disposal at the time the Elizabeth plant was designed.

Early barging difficulties required time to solve: long loading times have been shortened to six hours through the development of a method for concentrating sludge. A sludge of 8.75 per cent solids is obtained by pumping sludge from settling tanks daily, decanting supernatant at regular intervals (the liquor is returned to the plant influent), and by controlling the moisture content of the sludge in a pre-mixing operation in which sewage is added at the point where sludge enters the discharge pumps. By present techniques, about 500 tons of sludge are loaded each hour. Lantern slides illustrated the sludge disposal facilities.

The Challenge of Wastes

"WASTES DISPOSAL—A JOINT MUNICIPAL AND INDUSTRIAL PROBLEM" by *Morris M. Cohn,* City Manager, Schenectady, N.Y., and Editor, Wastes Engineering.

If industrial production is to expand, processing waters must be available and the used water must be discharged with some content of waste products. The problem of industrial waste treatment should be considered not solely the responsibility of industry, but jointly as that of the industry and the community in which it is located; and each should share equitably in treatment costs.

Mr. Cohn pointed to a basic approach which should be made by industry: 1. To prevent rather than cure; 2. To reclaim wherever possible; and 3. To treat, to an extent required to meet sensible water quality standards, those wastes which cannot be prevented or reclaimed. More research is needed to solve new waste treatment problems.

Interstate Clean-up Program

"CURRENT PROGRAM OF THE INTERSTATE SANITATION COMMISION" by *Seth G. Hess,* Director and Chief Engr., Interstate San. Comm.

Reporting on the present "most encouraging status" of the Interstate Sanitation Commission accomplishments in pollution correction, Mr. Hess indicated that by 1954 no untreated waste will be discharged into any interstate water used for bathing or fish life. In New York State, only the cities of Peekskill and Upper Nyack now discharge untreated sewage. The New York City program represents a special case: Sewage works construction is limited by practical considerations to about $13.5 million dollars a year; the city has maintained that rate for the past several years.

In Connecticut, a treatment plant has been completed by every city which discharges wastes into inter-

Programmers

Morris M. Cohn, City Mgr., Schenectady, N.Y. — *A. A. Kalinske*, Dir. of Development, Infilco, Inc. — *Andrew Palmer*, Supt. Plant, Plainfield, N.J. — *C. B. McMenamin*, Supt. Treatment, Middlesex, N.J.

state waters. A considerable number of new plants must be provided in New Jersey. Many of these are already under construction, and most of the remainder are in the planning stage.

After 16 years of accomplishment, the I.S.C. program is moving rapidly to a state of stabilization. Once complete control of raw sewage is attained, the problems remaining will involve the control of industrial wastes, improvement and modernization of older sewage treatment plants.

In reply to a question from Prof. Rudolfs, Mr. Hess explained that the Commission has not indicated that it contemplates raising standards of effluent quality—but that there is a possibility this will be done in the future.

Robert S. Shaw, Dist. Chief Pub. Health Engr., State Dept. Health, reviewed the common objectives of the I.S.C., Incodel, and the State Dept. of Health. He noted that the I.S.C. standards are based on both expected use of the receiving water and on the quality of the effluent. The practical point of view, in his words, is that "In the hands of mature administrators, effluent standards provide an excellent yardstick—but they should not and cannot be used as a micrometer."

Best Use of Filters

"Loading and Performances of High Rate Trickling Filters—Operated in Series and Parallel" by *C. Bernard McMenamin*, Supt. of Sewage Treatment, Borough of Middlesex, N.J.

The purpose of studies reported in this paper was to compare the efficiency of a unit volume of filter stone used in single and double filtration. The Middlesex plant employed chemical treatment and chlorination, treating municipal waste high in B.O.D. (because of a considerable sugar content contributed by industrial wash). High rate filtration was investigated both for fundamental information and for data relating to local needs.

The filters were 15 ft. diam. units with a 4 ft. depth of stone. These units were operated in parallel for two years and in series for two years; variations of ratios and of recirculation were employed; all sampling represented the period 11:00 A.M. to 3:00 P.M.

Average B.O.D. loading applied ranged from 540 to 628 ppm. Results indicated a unit volume of stone to be at least 2 times as great when used in double filtration as compared with single filtration. In parallel operation, the B.O.D. of the effluent was approximately double that resulting with series operation. Effluent quality, therefore, was better using series operation than using parallel operation—even when the loading in series operation was twice as great. No ponding was encountered with either type of operation.

Operators' Symposium

The operators' symposium followed a breakfast and business meeting devoted to the election of officers.

Brief discussion was given to a report on legislation: New Jersey has passed a state enabling act providing the possibility of social security coverage for municipal employees. This is applicable only to those not covered by any pension fund. Details of how coverage may be obtained were discussed.

"Control of Beach Pollution" was the subject of extended discussion. The problem was described as an economic matter importantly affecting the prosperity of many coastal communities of the state. A committee, including representatives of various agencies involved, has been set up both for technical and publicity purposes. Discussion of the several approaches to control of beach pollution was presented by the following:

Jesse B. Aronson, Dist. State Health Officer, Central District: Sewage plant operators can be responsible only for pollution which reaches the treatment plant.

L. M. Friedrich, Dist. Chief Pub. Health Engr., Central District: Repair and maintenance of plant equipment, painting, general good housekeeping, and advance supplies for operation are important considerations.

Adam Reichardt, Supt., Ocean Township: The committee can serve a useful purpose by securing good publicity in advance of the bathing season.

Joseph Emmons, Health Officer, Long Branch: Beach debris is an important consideration.

W. Stanley Applegate, Health Officer, Neptune Township: The local plant operator and health officer should participate in local service clubs.

A. H. Fletcher, Dir. Bur. of Envir. San. State Dept. Health: The local health officer is first in responsibility; regional laboratories will prove helpful in the technical aspects; newspaper publicity will be most effective when issued by State authorities.

N.J. Dept. Hlt. Engrs. Harry Greenfield, L. A. Greenberg, and A. T. Leahy — *G. Cameron, Supt.; J. Shiner, Engr.; and R. Quinn, Supt. Pumping, Atlantic City Sewerage Co.* — *C. Coleman, Engr., DeLaval Pump Co. I. M. Glace, Cons. Engr., Harrisburg, Pa. C. Cromwell, Sales Mgr., DeLaval Pump Co.*

V. W. Langworthy Appointed Institute Research Chemist

The Chlorine Institute, Inc. of New York announces the appointment of Virgil W. Langworthy as Research Chemist succeeding Harry A. Faber, recently resigned.

Mr. Langworthy received his B.S. degree in Bacteriology from Michigan State College in 1946. He is a U.S. Naval Reserve Officer and a member of American Water Works Association. He comes to the Institute from Adrian, Michigan, where he was Chief Operator of the Municipal Water Conditioning Plant.

Profits from Metal Wastes

New Ion Exchange Process Recovers Chromic Acid and Demonstrates Other Operating Advantages

by C. F. PAULSON, *Research Engr., Special Applications Dept., The Permutit Co. New York, N. Y.*

IN chemical operations, few jobs cause the engineer so much grief as separating substances he wants from those he doesn't want. He faces many problems like taking minerals out of boiler feed water and cleaning up plant wastes, especially when these wastes are valuable. In the last few years, he has discovered that the slickest way to do these jobs and many others is to use an ion exchange process.

Ion exchange can be considered an economical method of treating wastes when valuable material can be recovered for re-use. However, it must be remembered that the regenerant solution produced through the exchange of ions should be of such a nature and character that it can be disposed of readily. Certain types of chemical wastes can be purified by ion exchange, producing a valuable effluent for re-use, but the regenerate effluent would be just as harmful for discharging into streams as the original wastes.

Recovery of Critical Materials

With federal, state and municipal governments becoming increasingly concerned over pollution of streams, rivers and other waters, industry is being forced to pay more attention to the treatment of harmful wastes. In other instances, there is an increasingly important need for the recovery of chromium and chromic acid caused by the Korean situation. The war-caused squeeze on these critical materials has created demands for equipment to recover chromium-containing ions from baths employed for anodizing aluminum, chromium plating and copper stripping. In these aforementioned processes, chromic acid becomes contaminated with metallic cations, lowering its effectiveness and requiring replacement as a certain amount is lost through dragout on the surface of the work.

Wastes Are Expensive

The wastes resulting from these sources have always been an expensive nuisance. Recently, with more attention being forced on stream pollution and the critical supply of chromic acid, a variety of disposal methods have been considered and installed.

During anodizing treatment, the chromate reacts with the metal surface dissolving some of the metal and producing trivalent chromium from the hexavalent form. For the several processes, such as bright dipping or copper stripping, this is necessary, but for other operations, such as electroplating, it is an unnecessary side reaction to the processing steps. However, in all processes, it results in consumption of the acid and produces a chromate salt which cannot be reused. This chromium solution is generally highly concentrated, toxic and most difficult to dispose of.

The only process known to be operating on a commercial scale, reducing stream pollution and returning the chromate in usable form to the treatment tank is The Permutit Company's ion exchange method which utilizes the exclusive synthetic resins, Permutit Q and Permutit S. The equipment required in an installation of this type is illustrated in Fig. 1.

Advantages of System

This system for supplementing chromate waste disposal facilities and recovering the chromate in useful form has several advantages:

Fig. 1—Chromate recovery by ion exchange. Left to right, Permutit Q unit and Permutit S unit. The parts and piping are fabricated of chromic acid resistant materials.

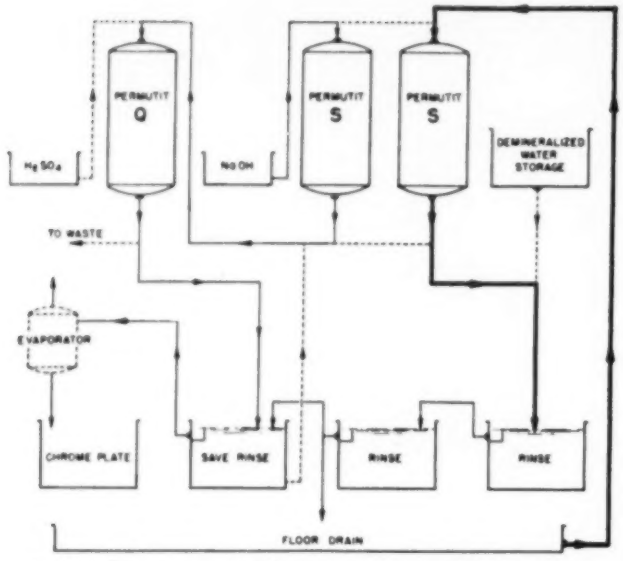


Fig. 2—Chromate recovery flow diagram. Ion exchange methods should utilize a "Save Rinse" unit. This conservation tank follows the plating tank, to which chromic acid is returned to compensate for dragout and evaporation losses.

1. When compared to conventional disposal equipment, initial and installation costs are reduced by 50 per cent.
2. Operating costs are lowered by 75 percent.
3. Approximately 80 per cent less floor space is required.
4. Reduces consumption of strategic materials by 90 per cent.
5. Reduces water and steam consumption by 85 per cent.
6. Insures better plating and anodizing efficiency.
7. Higher quality finished product is assured.

Ion Exchange Process

The system consists of a cation exchanger to remove metallic cations from the strong chromic acid anodizing solution and an anion exchanger to recover the chromate from the dilute rinse solutions. It is installed at the plant of a leading manufacturer of airplanes near New York City.

The newest recovery process employs ion exchange resins. By this process, one ion in solution is exchanged for another by means of an insoluble granular material which can function in a reversible manner. In the process, hydrogen ions are exchanged for metallic ions. Then the cycle is completed with the utilization of ion exchange resins for recovery of chromium ions. It is the first complete ion exchange chromate recovery process to be used on an anodizing line. With almost a year of satisfactory operation, great savings have been realized. See flow diagram, Fig. 2.

The anodizing bath is operated at a pH between 0.7 and 0.9 and contains 50 to 70 grams per liter of CrO_3. Each day, a portion of the bath is withdrawn and passed through a bed of the high capacity cation ion exchanger Permutit Q. All of the aluminum and other metallic cations are removed from this portion and hydrogen cations are substituted. The effluent solution has a very low pH and is returned and mixed with the remainder of the chrome bath, lowering the overall metallic content and pH somewhat. Anodizing is not interfered with in any way and can be continued during the treatment.

Once a Day Operation

The cation exchange unit was sized so that operation once a day is sufficient to maintain the metal concentration at a reasonable level. Experience has shown that the pH in the bath can be maintained within very close limits and that very little CrO_3 must be added. As the permissible metallic concentration is high in the anodizing tank, it is necessary only to remove and treat a small fraction of the total bath in order to maintain a satisfactory metal concentration. Thus, the treatment cycle is short, commonly taking less than one hour.

When the Permutit Q resin becomes exhausted, it is regenerated by contacting it with sulphuric acid. The effluent sulphuric acid is sent to waste, carrying with it the metallic cations. This acid is then washed from the unit with water. It is also necessary to displace the chromic acid with water and this results in some desirable dilution which compensates for dragout and evaporation losses in the bath.

Anion Exchange of Rinse Water

The incorporation of a "save rinse" tank will normally conserve from 60 to 90 per cent of the chromate being dragged from the treatment tank. The remaining chromate is still troublesome and requires treatment. Ion exchange offers a very satisfactory solution here as well. Instead of sending the rinse water to treatment and thence to waste, it can be sent through a bed of an anion exchanger, Permutit S, which has the property of removing the chromate ions from solution and substituting hydroxyl ions.

On the treatment of virtually pure chromic acid, this results in the formation of water in place of the acid. Since the equipment is also capable of operating as a water demineralizer, the rinse tank is initially made up with demineralized water. Hence, when the chromic acid is removed, the water is once again demineralized, and can be returned to the rinse tank for reuse. This conserves water and, in some cases where hot rinses are used, conserves heat in the water; it simultaneously offers the manifold advantages of providing demineralized water for rinsing. The flow rate of treatment may be so controlled that the pH of the rinse tank may be kept at the value which gives the most satisfactory surface.

When the Permutit S resin becomes exhausted with chromate, the flow either is halted or shifted to an alternate unit, and the resin is regenerated with caustic soda. Caustic soda regen-

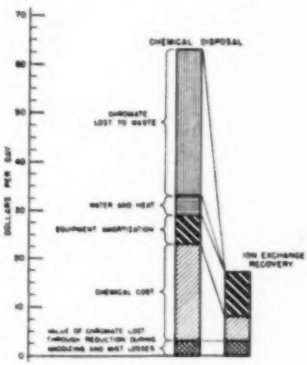


Fig. 3—Cost comparison of chemical disposal and ion exchange recovery methods of chromic acid treatment.

erant drives out the chromate anions and replaces them with hydroxyl anions. The effluent solution from the unit is alkaline and contains all the chromate. For this installation, it is necessary only to pass the alkaline regenerant effluent solution from the anion exchanger through the cation exchanger. Here, the sodium ions are removed, forming free chromic acid. This solution can be returned directly to most anodizing and stripping baths; but for return to a plating bath, some evaporation may be necessary.

Cost Savings

The aircraft manufacturer's records (kept of the bath under present circumstances as compared to similar figures before the recovery equipment was installed) indicate that use of the equipment results in savings of more than 100 pounds per day of chromic acid. Heat and water are conserved also and, less the cost of repumping the water, amount to savings of about $4.00 per day. A conventional treatment plant for holding, reduction of chromate, and neutralization would cost several times the price of recovery equipment and would have an operating cost for chemicals in excess of $20.00 per day plus the cost of an operator. The recovery equipment may be installed right in the plating room and operated by the plating personnel so that no labor cost is involved.

A cost comparison of recovery and disposal methods is shown graphically in Fig. 3. The operating cost of the recovery equipment at the plant of the aircraft manufacturer is approximately $17.00 per day, including regenerant chemicals, equipment amortization and estimated resin replacement. This compares favorably with the disposal method, costing $63.00 daily. The resin replacement can only be estimated as there has been no need for replacement as yet. Summarized, these comparative costs on a daily basis are:

	Disposal	Recovery
Value of lost CrO_3	$13.00	$3.00
Equipment Amortization*	6.00	9.00
Chemical Cost	20.00	5.00
Water and Heat	4.00	0.00
Total	$63.00	$17.00

* includes ion exchange replacement

Joint Sewage Treatment Undertakings Increasingly Adopted

The so-called "Joint Meeting" plan of combining the sewage disposal operations of two or more communities, for both economic and technical reasons, has proven practical and beneficial for about two decades in the State of New Jersey. In this scheme a common trunk sewer and sewage treatment plant serves two or more political subdivisions, the various communities served paying a pro-rated charge for the handling of the sewage from each on a metered basis.

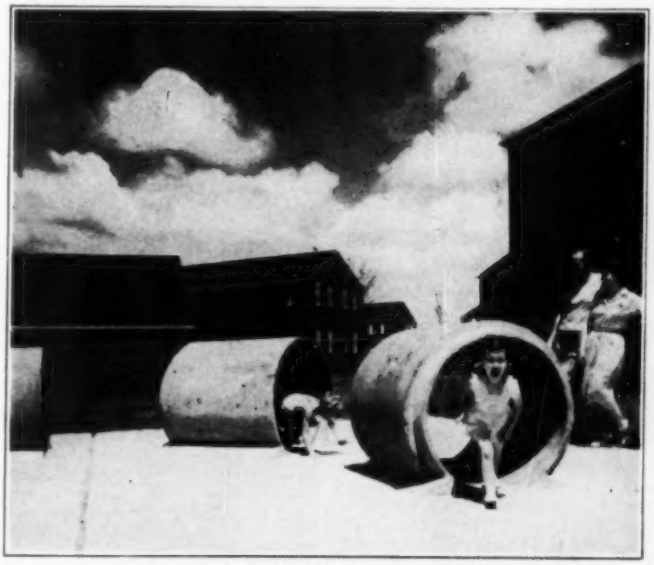
Such joint agreements between contiguous political subdivisions that have sewage disposal problems to solve are being increasingly used, with benefits to all concerned. An outstanding recent case is that of Bristol, Va. and Bristol, Tenn. Even though these cities are in different states a practical agreement has been consummated. Another inter-state agreement of several years standing is that of Bluefield, Va. and Bluefield, W.Va. Also of long standing has been the joint undertaking of the eleven or more communities in Los Angeles County, Calif., operating as the Sanitation Districts (Combined) of Los Angeles County.

Based on the successful and economical accomplishments of the Los Angeles County Sanitation Districts, the seven Sanitation Districts in Orange County, Calif., are undertaking a similar scheme of joint outfall and one central sewage treatment plant, which will serve all but two cities in Orange County.

Other joint sewage disposal undertakings of note include the following:

California's East-Bay Municipal Utility District late in 1951 began the collection and treatment of sewage from Oakland, Berkeley and four other East-Bay cities. In Kentucky the cities of Covington, Newport and 13 contiguous communities have formed a Metropolitan Sewer District to be served by a central treatment plant. The Allegheny Sewerage Authority proposes to serve Pittsburgh, Pa. and a large number of contiguous communities with one large central treatment plant and others as may be required on a joint or individual basis dictated by topography. In Oregon, Olympia, and Tumwater will jointly construct a disposal system.

There are a number of other instances of joint undertakings in sewage collection and disposal of longer standing than those listed above. However, the more recent agreements point to the proven effectiveness and desirability of joint sewerage undertakings to a greater extent than ever before.



NOVEL USE FOR CONCRETE SEWER PIPES.

Keeps the kiddies happy and healthy in the playground of Glen Oaks Village on Long Island near New York City. Note how this circle of pipe sections are blocked with filets of cement mortar to preclude rolling of the sections and possible injury to the youngsters.

Pharmaceutical Waste Treatment

Trickling Filters Successfully Handle Liquid Wastes at Upjohn Plant, Kalamazoo, Mich.

by E. HURWITZ[1], KEITH H. EDMONDSON[2], *and* SAMUEL M. CLARKE[3]

THE problem of disposing of antibiotics wastes was foreseen by the management of the Upjohn Co. when plans for their new Portage Road Plant were undertaken. Since the discharge enters Portage Creek, a small stream which flows through a city park and into the Kalamazoo River, a high degree of treatment is required to prevent objectionable conditions in the creek.

Laboratory studies were made to determine the degree of purification which could be accomplished by applying available treatment processes to the manufacturing wastes. These studies were made by Dr. F. W. Mohlman and E. Hurwitz.

Preliminary Studies

The wastes of immediate concern were those which originated in the manufacture of penicillin and streptomycin. Analysis of wastes from a pilot plant showed that the BOD of the spent beer from penicillin manufacture ranged from 6,000 ppm to as high as 32,000 ppm and averaged approximately 13,000 ppm; suspended solids averaged 400 ppm and pH was between 2 and 3. This pH was raised to between 7.4 and 7.9 by alkali wash waters before discharge to sewer.

Streptomycin wastes were much weaker, ranging in strength from 200 ppm to 5,000 ppm BOD and averaging 2,500 ppm. Occasional spoiled batches of penicillin had a BOD value in excess of 32,000 ppm.

The laboratory tests were designed to determine: (1) if these wastes could be treated on biological filters, and, (2) if they would be suitable for treatment by anaerobic digestion.

The preliminary experiments were started in November of 1945 and continued through April of 1946. During this period, intensive studies were made on the treatment of the concentrated wastes on trickling filters in single stage and two stage arrangement. The effect of dilution with filter effluent and river water in various proportions was studied, as was also the effect of pre-aeration before biological treatment. The results of these studies indicated that streptomycin wastes could be treated successfully on trickling filters at a rate of 1600 lbs. per acre-foot per day with 98 per cent reduction of BOD. Penicillin wastes required dilution ranging from 1 to 4 up to 1 to 9 with either filter effluent or water.

These tests also established the desirability of pre-aerating the spent penicillin beer before treatment on trickling filters. Pre-aeration periods of one to four hours reduced the BOD an average of 20 per cent.

The best treatment was obtained by aerating the concentrated spent beer for four hours and then diluting with four parts of water before treatment on trickling filters. Reductions in BOD of 96 per cent were obtained with application at the rate of 1,500 pounds of BOD per acre-foot. Observation of the experimental filters, Fig. 1, showed a tendency toward heavy accumulation of biological growth on the stone. Recommendations for the full-scale plant suggested that backwashing of the filters was desirable.

Fig. 1—Experimental trickling filter units for study of pharmaceutical wastes

Anaerobic digestion proved to be unsuccessful with penicillin wastes. Gas production was either nil or very low and what gas was produced contained very little methane.

The Waste Treatment Plant

Based on the results of these experiments, a plant was constructed to treat 700,000 gpd of waste. This volume included the sanitary wastes from an employee population of 1,500 and a residential population of 2,500, and the wastes from penicillin-streptomycin manufacture. The total anticipated BOD amounted to more than 2,700 pounds per day.

The principal units comprising the plant as shown in Fig. 2 are:

(a) Two penicillin waste holding tanks, 25,000 gal. capacity each. Equipped with spargers for aeration. Estimated retention period, 24 hours. Aerated waste is pumped periodically at 25 gpm rate to main treatment plant during the night hours.

(b) Two primary settling tanks, each 10 feet deep, with a capacity of 7,800 cu. ft., providing a retention period of 2 hours at 0.7 mgd flow.

(c) Two trickling filters, each 90 feet in diam. by 6 feet deep, designed for a unit load of 1,500 pounds BOD per acre-foot. Filters are so arranged that they can be dosed either in series or parallel, and flow can be reversed when dosing is in series.

(d) Two final settling tanks, each 8 feet deep, with a capacity of 7,800 cu. ft. and retention period of 2 hours at a rate of 0.7 mgd.

(e) A chlorine contact tank with 20 minute retention period.

(f) One sludge digestion tank with 15,000 cu. ft. capacity.

(g) Sludge drying beds totaling 3,000 sq. ft. area.

Trickling Filter Operation

Some of the early operating problems encountered were described by Hilgart.* As the pharmaceutical man-

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[3]Partner, Greely and Hansen, Chicago, Ill.

*Hilgart, A. A. Design and Operation of a Treatment Plant for Penicillin and Streptomycin Wastes. Sew. and Ind. Wastes, 22, 207 (1950).

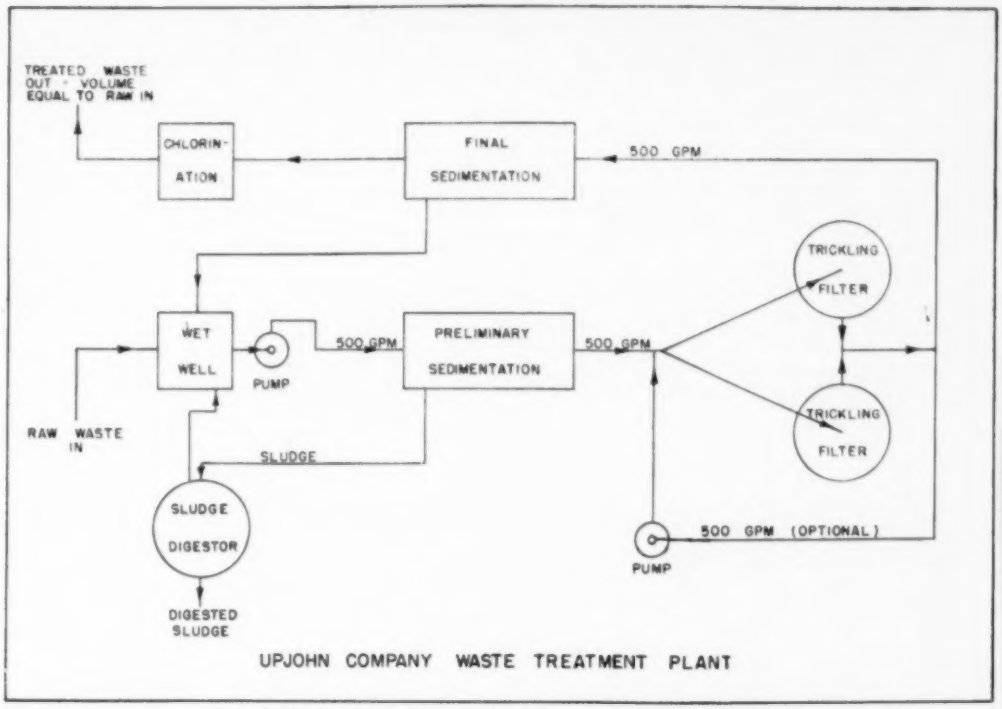

Fig. 2—FLOW DIAGRAM. Units comprising pharmaceutical waste treatment plant

ufacturing operations were moved to the new site, the character and strength of the waste changed. Improvement in manufacturing methods also caused changes in the character of the waste. Some of the problems were corrected in part at the manufacturing plant by the installation of efficient grease traps for removal of grease and oil. Toxic solvents were removed by efficient solvent recovery systems and by aeration in the holding tanks. Aeration of the antibiotics wastes at the manufacturing plant resulted in approximately 40 per cent reduction in BOD.

The effect of changes in the manufacturing processes, the increased number of products, and volume of production was noticeable at the waste treatment plant and resulted in the deterioration of the plant effluent. Difficulty in operation of the sludge digester, which had been anticipated from the original experiments, was further aggravated by a solids load many times as great as the original studies indicated. Some of the solids load was the result of biochemical coagulation and precipitation in the trickling filters.

Plant scale tests were made to determine the best method of operating the filters by manipulating the dosing sequence. The pumping capacities and the arrangement of the filters are such that filters may be dosed (1) in series at a rate of 500 gpm each, (2) in parallel at a rate of 250 gpm each with the effluent from the primary settling tanks, or (3) in parallel at a rate of 500 gpm, half of which is effluent from the primary tank and half recirculated filter effluent.

The degree of treatment obtained was equally good with either method. However, operational difficulties mitigated against the use of methods 1 and 2. Series operation was undesirable for two reasons: (1) the volume that could be applied to the filter was limited, resulting in low recirculation ratios, and (2) the lead filter became clogged with profuse biological growths which were encouraged by the high rate application of settled waste, while the second filter became clogged by the unsettled solids sloughed off the lead filter.

Parallel operation as described under method 2 is satisfactory, except that the rate of application is relatively low (2.4 mgad); also, the amount of effluent that can be recirculated is low and hydraulic flushing is greatly reduced. The advantage of this method is that the recirculated effluent is settled a total of 4 hours (primary—2 hours, final—2 hours) before reapplication to the filters, thus removing the possibility of clogging. This method of operation is usually employed during the sloughing-off period of the filters to avoid BOD and solids overloading.

The third method of operation has been adopted for routine operation. It permits a volume loading of the filters up to 4.8 mgad by dilution of the filter feed with an equal amount of effluent.

The results of two-year operation of the trickling filters are shown in Table I. Over-all reduction of BOD in the plant has been as high as 97.8 per cent. The yearly average approaches 90 per cent. The settling tank effluents were diluted by re-cycling the filter effluent. Recirculation rates ranged from 1 to 2 to 1 to 9. Better filter efficiency and filter effluents were obtained at the higher rates. Based on a recirculating capacity of 400 gpm, the load applied to the filters averaged 2,540 pounds per acre-foot per day, which was considerably higher than the 1,500 pounds design capacity. Removal of BOD averaged 1,480 pounds per acre-foot.

Laboratory Digestion Experiments

The digestion experiments made during the original investigation in the

latter part of 1945 indicated that the antibiotics wastes would digest with difficulty. Experience at the waste disposal plant confirmed this indication. The characteristic was impressed on the management by odor complaints arising from an improperly functioning digester. Corrective measures were taken to improve the operation of the digester and, at the same time, laboratory studies were initiated to investigate more thoroughly the reasons for its failure.

The laboratory studies investigated the possibility that the digester might have been loaded at too high a rate and that certain solvents used in the manufacturing process might be toxic to the anaerobic microflora responsible for destruction of organic matter. Also investigated was the use of chemical additives reported to be beneficial in stimulating anaerobic digestion.

A series of eight laboratory digester assemblies was set up. The experiments were started with one liter of actively digesting sludge as seed and daily increments of sludge were added until a working volume of three liters was obtained. Thereafter, supernatant was withdrawn at the same rate at which sludge was added. Digester No. 8 was fed with sludge free of ethylene dichloride which was obtained by settling the antibiotic plant beer wastes. The digesters were kept at room temperature which averaged about 75F. The volume of gas produced was used to measure the progress of digestion. Total solids in the raw sludge ranged from 11.6 per cent down to 4 per cent, and volatile solids from 60 per cent to 28 per cent.

Table II summarizes the results of this series of digestion experiments. These experiments indicate that antibiotics wastes digest with difficulty. The results obtained in Digesters 1, 2, and 3, in which the feed load was varied, show that greater digestion efficiency is obtained at lower rates of feed and indicate that wastes of this character require large digester space and low daily feed rates.

The experiments with chemical additives, Digesters 4, 5, and 6, show that none of those used were of any significant benefit.

The solvent, ethylene dichloride, Digester 7, had no inhibitive effect in amounts up to 10 ppm. However, the results obtained from anaerobic digestion of antibiotic spent beer sludge, free of solvents, was considerably better than the mixed sludge, which indicates that these solvents did inhibit digestion. Later tests using higher concentrations of ethylene dichloride confirmed this conclusion.

A second series of laboratory tests was run to determine the effect of temperature on anaerobic digestion of the mixed sludges and to observe the effect of higher concentrations of calcium acetate on digestion and the effect of higher pH. The experiments were started, as in the first series, with a seed of actively digesting sludge.

The results of these tests are shown in Table III. The rate of gas production at temperatures usually used in digestion of sludges, 90°±, is low compared with normal sludge, although it was higher than the rate at 75°. However, digestion of antibiotic sludge free of solvents at 90° resulted in gas production approaching normal rates. Twenty-five ppm of $Ca(O\,Ac)_2$ slightly inhibted gas production at both 75° and 90°. Increasing the pH to 8.0 increased gas production at 75° and reduced it at 90°.

Table I
Operation of Trickling Filters

Year	Month	GPD Volume	ppm BOD Raw	ppm BOD Settled	ppm BOD Filter Eff.	ppm BOD Final Eff.	% Reduction by Filters	% Reduction Overall	pH Final
1949	Jan.	70,800	4,170	1,590		317		92.4	7.5
	Feb.	458,000	2,640	1,085		234		91.2	7.6
	Mar.	240,000	1,410	578		83		94.1	7.9
	Apr.	177,000	1,990	642		134		93.3	7.4
	May	150,000	2,160	400		48		97.8	7.7
	June	165,000	2,650	655		103		96.1	8.1
	July	153,500	2,740	690		107		96.1	8.4
	Aug.	160,000	2,540	630		105		95.9	8.3
	Sept.	155,000	1,650	670		109		93.5	7.8
	Oct.	142,500	2,310	710		124		94.6	7.7
	Nov.	157,500	1,210	667	203	188	69.8	89.1	7.8
	Dec.	175,500	1,680	666	185	146	72.3	91.3	7.8
1950	Jan.	196,000	1,920	810	242	204	70.1	89.4	7.6
	Feb.	202,000	1,660	750	281	256	62.5	84.6	7.4
	Mar.	199,000	1,560	723	341	307	52.8	80.3	7.4
	Apr.	178,000	1,950	938	413	303	56.0	84.5	7.4
	May	187,000	1,615	773	175	125	77.3	92.2	7.7
	June	214,000	1,340	675	95	66	86.0	95.8	7.7
	July	209,000	1,140	684	170	113	75.0	90.1	7.7
	Aug.	232,000	1,025	688	122	97	82.7	90.6	7.5
	Sept.	190,000	1,350	720	141	110	80.5	91.9	7.4
	Oct.	218,000	1,230	780	178	132	77.2	89.3	7.3
	Nov.	332,000	1,220	773	160	136	79.3	88.9	7.6
	Dec.	338,000	1,265	765	196	158	74.3	87.5	7.5
1951	Jan.	340,000	970	670	146	108	78.2	88.8	7.4

Table II
Laboratory Digestion Experiments—Series I

Dig. No.	Type of Sludge	Temp. Dig. °F. Aver.	Chemical Kind	Add. Amt. ppm	Volume Sludge ml	Wtd. Aver. Solids %	Wtd. Aver. Vol. %	Solids Added gm	Vol. Added gm	Gas Produced Total cc	Cu. Ft. Gas Per Lb. Sol.	Cu. Ft. Gas Per Lb. Vol	pH
1	Raw	75	None	—	4,800	7.61	53.71	365	196	7,970	0.36	0.65	6.6
2	Raw	75	None	—	3,600	7.61	53.71	274	147	7,985	0.47	0.87	6.7
3	Raw	75	None	—	1,200	7.61	53.71	91	49	6,630	1.17	1.74	7.0
4	Raw	75	$Ca(O\,Ac)_2$	10	4,800	7.61	53.71	365	196	9,585	0.42	0.78	6.7
5	Raw	75	$(NH_4)_2SO_4$	10	4,800	7.61	53.71	365	196	9,515	0.42	0.78	6.6
6	Raw	75	O-dichloben	10	4,800	7.61	53.71	365	196	8,830	0.39	0.72	6.6
7	Raw	75	$C_6H_4Cl_2$	10	4,800	7.61	53.71	365	196	9,270	0.41	0.76	6.6
8	Antibiotic free of $C_6H_4Cl_2$	75	None	—	5,600	4.4	66.4	246	163	27,715	1.80	2.73	7.1

Table III
Laboratory Digestion Experiments—Series II

Dig. No.	Type of Sludge	pH Feed	Temp. Dig. °F.	$Ca(O\,Ac)_2$ Added ppm	Volume Sludge ml	Wtd. Aver. Solids %	Wtd. Aver. Vol. %	Sol. Added gm	Vol. Added gm	Gas Produced Total cc	Cu. Ft. Gas Prod. Lb. Sol. Added	Cu. Ft. Gas Prod. Lb. Vol. Added
1	Raw	7.0	75	0	4,100	6.25	48.52	256	124	15,320	0.96	1.98
2	Raw	5.0	75	0	4,100	6.25	48.52	256	124	22,440	1.43	2.90
3	Raw	7.0	75	25	4,100	6.25	48.52	256	124	11,380	0.71	1.47
4	Raw	7.0	90	0	4,100	6.25	48.52	256	124	32,560	2.04	4.21
5	Raw	8.0	90	0	4,100	6.25	48.52	256	124	11,780	0.74	1.52
6	Raw	7.0	90	25	4,100	6.25	48.52	256	124	34,800	2.18	4.50
7	Antibiotic	7.0	90	0	4,100	3.79	30.14	156	47	26,350	2.70	9.00
8	Antibiotic	8.0	90	0	3,350	3.68	30.28	133	37	15,000	1.81	6.50

Operation of Plant Digester

Based on prior plant scale experience and on results of these laboratory tests, steps were taken to eliminate most of the ethylene dichloride from the plant influent and to remove at the source the filter-cel which was being discharged to the sewers. In addition, a gas meter was installed and a schedule for routine analysis of the digester content for pH, volatile acids, carbon dioxide, and solids was set up. Carbon dioxide determination has proved to be a sensitive indicator reflecting changes in the digester condition before pH changes, sludge solids, or organic acids. The optimum CO_2 content for this digester seems to be 33±2 per cent and variations from

Table IV
DIGESTER OPERATING DATA

Date		Raw Sludge Gal. Per Day	Raw Sludge Total Solids %	Raw Sludge Vol. Solids %	Digested Sludge Gal. Per Day	Digested Sludge Total Solids %	Digested Sludge Vol. Solids %	Supernatant Gal. Per Day	Supernatant Total Solids %	Supernatant Vol. Solids %	Gas Cu. Ft. Per Day	Gas CO_2 %	Vol. Acids %
1949	Jan.	560	7.8	48.0	290	5.9	53.5						
	Feb.	280	6.0	54.0	280	4.8	51.3						
	Mar.	350	6.3	53.7	60	6.1	35.5						
	Apr.	380	7.0	42.8	220	5.3	40.2						
	May	800	4.85	49.3	545	5.7	50.9						
	June	470	5.43	53.5	430	5.3	60.2						
	July	754	7.2									40	
	Aug.	1,220	6.4	46.5	0							55	
	Sept.	0	—	—								22	
	Oct.	470	5.96	47.5	0							31	244
	Nov.	685	6.3	52.7	0							34	237
	Dec.	920	6.6	55.3	145	8.2	52.7	775	3.7	55.7	1,770	34	143
1950	Jan.	1,140	7.8	38.1	384	7.3	28.8	760	3.0	50.0	2,220	35	180
	Feb.	917	8.3	31.1	850	7.0	27.8	70	3.0	45.0	2,310	35	221
	Mar.	1,050	7.16	35.0	690	7.5	24.3	360	3.0	40.0	2,630	34	150
	Apr.	2,420	6.05	49.3	625	8.5	27.8	1,800	2.7	37.0	4,940	35	494
	May	2,310	5.7	48.1	766	5.9	36.7	1,540	3.0	37.0	5,100	35	208
	June	2,300	6.35	40.0	688	6.5	31.6	1,630	3.1	38.8	3,600	34	167
	July	1,980	5.8	48.8	605	6.6	31.9	1,375	3.5	41.3	3,270	35	387
	Aug.	1,730	6.8	46.1	707	6.2	36.4	1,020	4.0	40.5	3,120	37	430
	Sept.	2,360	6.3	46.0	417	6.2	37.4	1,940	4.4	36.3	3,810	35	249
	Oct.	2,560	6.5	45.7	282	5.8	37.9	2,280	4.0	42.0	3,220	35	184
	Nov.	3,240	5.4	43.9	480	5.0	37.4	2,760	3.8	34.7	2,900	33	308
	Dec.	3,590	4.9	56.2	565	4.9	40.0	3,025	3.6	49.0	6,110	33	—
1951	Jan.	3,610	5.6	58.6	848	6.8	38.3	2,760	3.4	45.5	6,940	34	—
	Feb.	3,400	6.1	59.7	670	7.6	38.1	2,730	3.2	46.7	6,675		

Table V
DIGESTER OPERATING DATA

Date		Solids—Pounds Per Day: Raw Sludge Total	Raw Sludge Volatile	Dig. Sludge Total	Dig. Sludge Volatile	Supernatant Total	Supernatant Volatile	Volatile Destroyed	Gas—Cubic Feet: Per Lb. Vol. Added	Per Lb. Vol. Destroyed	% Vol. Solids Destroyed
1949	Dec.	510	280	100	52	240	130	100	6	18	36
1950	Jan.	740	280	230	67	190	95	120	8	18	43
	Feb.	635	200	500	140	18	8	50	11	46	25
	Mar.	630	220	430	105	90	36	80	12	33	36
	Apr.	1,220	600	440	120	405	150	330	8	15	55
	May	1,100	530	380	140	390	140	250	10	20	47
	June	1,220	490	360	115	320	165	210	7	17	43
	July	960	470	330	105	400	165	200	7	16	42
	Aug.	980	450	370	135	340	140	175	7	18	39
	Sept.	1,240	570	220	80	710	260	230	7	17	40
	Oct.	1,390	635	140	50	760	320	265	5	12	42
	Nov.	1,460	640	200	75	875	305	260	5	15	41
	Dec.	1,470	825	230	90	910	445	380	7	16	46
1951	Jan.	1,680	980	480	185	785	355	440	7	16	45
	Feb.	1,730	1,030	425	160	730	340	530	6	13	52

Digester loading based on solids added = 0.075 lbs. per cu. ft. = 2.25/mo.
Digester loading based on volatile solids = 0.036 lbs. per cu. ft. = 1.08/mo.

this content indicate that the loading schedule should be increased or reduced, as the case may be.

Digester operating data are given in Tables IV and V. The average loading based on solids feed was 2.25 pounds per cubic foot of digester space per month. Based on volatile solids, the average loading was 1.08 pounds per month. These values are very low compared with normal design loads of 2.75 to 3.50 cu. ft. per month. However, they are probably reasonable when the nature of the raw material and the low volatile content are considered. Similarly, the gas produced per cubic foot of volatile matter is low when compared with that produced by domestic sewage sludge.

Conclusion

The results of these studies, both in the laboratory and on full plant scale, show that the liquid wastes from a pharmaceutical plant can be successfully treated on trickling filters at reasonable loading and with high percentage removal.

The solids collected at the treatment plant can be digested, but only at low feed rates and close control.

Acknowledgment

The authors wish to acknowledge the assistance of Mr. L. B. Tompkins, superintendent of the waste treatment plant, for providing many of the analyses and for plant manipulation during these tests.

Betty Jane Taylor Voted Egmont Smith Scholarship Award of Southwest Section

Betty Jane, daughter of Frank S. Taylor, Superintendent of Water and Sewage Treatment at Oklahoma City, Okla., has been voted the Egmont S. Smith Memorial Scholarship Award by the Trustees of the Scholarship Fund of the Southwest Section of A.W.W.A.

Available to sons and daughters of water works operators, the Award, in the form of a check, is voted to the most deserving student qualifying for the Scholarship Award. Cash for the Award is derived from interest from securities in the Egmont S. Smith Memorial Fund, which was established by friends of the late Egmont S. Smith, long-time leader and mainspring in the Southwest Section and other water and sewage operator groups in the Southwest. Mr. Smith was a former director of the A.W.W.A. also.

The Award voted Betty Jane Taylor in March constitutes the second scholarship award made by the Trustees during the past year. It was their decision, approved by the Section Trustees, to make two Awards each year (now amounting to $300 each) rather than make a single award of double the amount. As the return from the Memorial Fund portfolio (Trust) increases the value of the Scholarship Award it will continue to increase from year to year to assist deserving students in the "water works family" of the Southwest.

WATER & SEWAGE WORKS

Report from Abroad

British Studies of Detergents in Sewage and Notes and Comments on Recirculating Filters

by JOHN FINCH, *Manager, Sewage Disposal Dept., Rotherham, England*

Detergents and Sewage Treatment

Several recent photographs of foaming at activated sludge plants dealing with sewages containing detergents, in the United States and Britain, have again brought up the subject of detergents and their effects upon the treatment of sewage. The position is by no means clear.

In Britain in the woollen districts where the major concentrations of various detergents are encountered, the consensus of opinion is that the matter is pretty well as it was—detergents are still difficult to deal with and no additional information has yet been brought to bear on the subject. Difficulties have been encountered at treatment plants where abnormal concentrations of detergents are met in the sewage.

Of the very appreciable amount of work on the effects of detergents on sewage treatment processes that has been carried out in Britain, most has been done at sewage works laboratories that have been concerned in the main, but not wholly, with the effects of the detergents on grease extraction processes. In this respect it has been definitely indicated that detergents do in fact influence the extraction of grease from the industrial sewages met with in the West Riding of Yorkshire.

Quite obviously the work on grease extraction constitutes an exceptional case of sewage treatment practice and this work has to some extent thrown out of perspective the primary issue of deciding to what extent detergents affect the normal sewage treatment processes. At the same time, it would appear that the inclusion of significant amounts of detergents increases the loading on oxidation processes. (It should be remembered that at Bradford, Halifax, and Huddersfield sewage treatment works, grease is extracted from the raw sewage by an acid-cracking and grease-solvent process.)

Furthermore, at Bradford it is stated that the B.O.D. of the settled sewage rose from 300 ppm. to 500 ppm. as a result of the inclusion of detergents in the sewage; and at Huddersfield where the sewage is acid precipitated, it was shown that 100 ppm. of detergents increased the B.O.D. load on the percolating filter installation by as much as 50 per cent. Lumb of Halifax has said that the presence of 100 ppm. of "Teepol" was sufficient to increase the suspended solids content of settling tank liquor after 4 to 8 hours quiescent settling by amounts over 30 per cent.

In a paper read before the Royal Sanitary Institute, Dr. Goldthorpe, Manager, and Dr. Nixon, at that time Chief Chemist, of the Huddersfield Sewage Department, reported on work carried out on percolating filters and in the Sheffield system of bio-aeration of a sewage from a textile industrial area which experimentally was made to contain 200 ppm. of "Teepol" and "Lissapol." It was shown that extended aeration periods are necessary in the treatment of this type of sewage by the activated sludge process. Concentrations of detergents of 200 ppm. caused the ponding of filters worked at 100 gallons a cube yard a day (characteristics of the applied waste being: oxygen consumed 90 to 150 ppm., B.O.D. 120 to 320 ppm.). The effluents were unsatisfactory. The control filter at this same rate continued to give a satisfactory effluent.

John Hurley, the manager of the Wolverhampton Sewage Department, and a well esteemed member of the sewage treatment profession in Britain, caused quite a commotion in the field with his findings published in a paper "The Influence of Synthetic Detergents on Sewage Treatment." This paper was read at the Annual Summer Conference of the Inst. of Sewage Purification in 1950. Hurley stated that in a large scale experiment carried out at Wolverhampton, the addition of the detergent "Teepol" in the concentrations so far used (about 122 ppm.) had had no perceptible effect on any stage of the sewage treatment process. Further, there had been no ill effect on the final effluent or on the stream receiving it. The sewage plant comprised a clariflocculator, followed by secondary settling, and then by percolating filters and humus or final settling tanks.

With a concentration of detergent (Teepol) of about 122 ppm. in the sewage, the detergent was almost completely removed during the treatment process. Some detergent was removed in the primary settling tanks, the clariflocculator assisting to this end. Hurley then states the evidence indicates that in the percolating filters, the detergent is most probably removed by oxidation.

The firm of Peter Spence & Sons, Ltd., in Britain, carried out some work some time ago covering the effects of various types of detergents on normal sewage. Concentrations of detergent in sewage of up to 200 ppm. were covered in the investigations. Four types of detergent were used in an attempt to cover the range likely to be used on a considerable scale. These were: 1. Higher alkyl sulphates. 2. Sulphated fatty alcohol. 3. Sulphated fatty esters. 4. Non-ionic type.

Their work showed that the first three types were without effect on the normal settlement of the suspended solids in sewage, and similarly that they were without effect on the improved settling which could normally be obtained by chemical treatment (precipitation). Since it has been established that detergent concentrations in normal sewage are unlikely to reach 200 ppm. for a long time, if at all, it would appear that the use of detergents is no real cause for concern at the normal sewage treatment works.

The fourth type of detergent mentioned, the non-ionic type, did cause some interference with normal settlement. Since this type of detergent is only likely to form a

A series of *Reports from Abroad* by Mr. Finch will present topics and opinions of timely interest. The author is chairman of the Northeastern Branch of the Institute of Sewage Purification, and a frequent contributor to British technical journals. He will welcome the opportunity of replying personally to readers of *Water and Sewage Works* who have questions or require additional information regarding the subjects discussed.—The Editors.

small portion of the total quantity used, there does not appear to be any real cause for concern.

Users of detergents have their own problems. Addressing a meeting in Bradford of the Textile Institute, a delegate commented on the refusal of the West Riding sewage works authorities to accept from the wool industry trade effluents containing detergents, and pointed out the economic advantages to the industry of using detergents. He said that bulk-working with detergents in wool-scouring was very desirable but was held up by the effluent treatment problem, and continued by saying it was an impossible position that a scientific discovery of such magnitude should be permanently held up by a sewage treatment problem.

It cannot be said that the Manufacturers of detergents in Britain have as yet gone to any particular trouble to co-operate with sewage treatment authorities on any of the peculiar problems associated with the treatment of sewage containing detergents.

In view of the fact that 75 per cent of the detergent output is used domestically, it is now quite certain that detergents of one sort or another are here to stay, and it is in the best interests of all concerned that a careful eye be kept on the development of these substances and their effects on sewage and sewage treatment practice.

Dewsbury and Recirculation

The curtailment of capital expenditure on sewage treatment schemes in Great Britain resulting from the general state of financial crisis has been responsible for much research into various "ways and means" of improving the performance of existing plants in need of additional capacity. Furthermore, there is taking place a phase of "utility" design in schemes of sewage treatment plant extension that has produced some very good conversions of existing plants. These take full advantage of modern thought, particularly related to the oxidation of sewage on percolating filters.

A very good example of this type of scheme is instanced in the Dewsbury (Yorkshire West Riding) proposed extension to the existing sewage works at Mitchell Laithes. This undertaking is necessitated by the extension of the drainage area to include the immediately adjoining districts of Mirfield and Batley which will increase the flow of sewage to the Dewsbury works from 2.4 m.g.d. to about 6 m.g.d.

The scheme in question is the result of large-scale experimental work carried out by E. H. Staynes, Manager of the Dewsbury sewage treatment plant, and R. S. Oldroyd, one time member of the Dewsbury staff, now at Cannock in Staffordshire. Staynes, a full-blooded Yorkshireman, and one of the shrewdest superintendents of sewage works in the West Riding, has produced a scheme which will save his authority a lot of money—at a time when money is really tight—and his proposals are worthy of study and consideration.

By way of the preamble it is interesting to study the history of sewage treatment at Dewsbury. The first steps toward sewage treatment were taken as far back as 1879 when the construction of the original works was commenced, and sewage was first treated in 1883. The process adopted was that of screening, settling in small tanks, and pumping of the settled sewage to the various areas of the farm lands which totalled 61 acres of specially prepared beds for intermittent downward filtration, and 60 acres of grassland for broad irrigation.

The second scheme completed in 1931 was designed to deal with a flow in dry weather of about 3 m.g.d, and was operated with satisfactory results until 1950 when the districts mentioned earlier in these notes were connected to the Dewsbury sewerage system. As a result of this move, the flow of sewage was more than doubled. Since 1931 intermittent negotiations have been carried out with the Borough of Batley, with a view eventually to treating the whole of this sewage flow. In 1939, the broad outline of this agreement was decided upon and at the same time negotiations with the Urban District of Mirfield were commenced with a view to including this area in the drainage scheme.

The present daily dry weather flow of 2.4 m.g.d. at Dewsbury is made up of 1.2 m.g.d. domestic sewage, 1 m.g.d. trade effluent and 0.2 m.g.d. infiltration water. The trade effluents are in the main derived from piece-scouring and dyeing of woollen goods (Dewsbury being in heart of the heavy woollen district of Yorkshire, which includes other "woollen" towns such as Bradford, Halifax and Huddersfield). As the industries of the two concerned districts are similar to those encountered at Dewsbury, it was thought reasonable to assume the ultimate nature of the combined raw sewage would differ but very slightly to that of the Dewsbury sewage.

Consequently, in view of the fact that the proposed additional flow would be about equal to the existing flow at the Dewsbury sewage treatment plant, experimental work was undertaken to decide the most economical and satisfactory scheme to deal with this increased load on the oxidation process of percolating filters.

Analytical statistics relating to the Dewsbury sewage are:

Raw Sewage	Oxygen consumed	125 ppm.
	B.O.D.	295 ppm.
Settled Sewage	Oxygen consumed	76 ppm.
	B.O.D.	219 ppm.

From the results obtained during the course of the investigations, it was concluded that the treatment of the combined Dewsbury and district sewage flow to Yorkshire Ouse River Board standards and requirements was practicable by utilizing either of the systems re-circulation or alternate double filtration at treatment rates up to about 200 gallons per cube yard of filter material per day. Generally speaking, it was noticed that alternating double filtration with daily alternation of the filters gave slightly better results than did re-circulation. It was also found that at these loadings, the existing percolating filters of 42,000 cube yards capacity would be large enough for the task in hand, new distributors capable of dealing with the increased flow being the only necessary addition to the installation. The re-circulation system was recommended.

A broad outline of the proposed new scheme to deal with the increased flow includes constant velocity grit channels, macerators, extensions to the primary settling tanks to give 10 hours capacity (or about 3.33 hours detention at maximum flow) and conversion of these tanks to mechanical desludging, provision of re-circulation pumps and new distributors for the filter plant, extensions to existing humus tanks to give a retention period in the tanks of about 3.7 hours allowing for 100% re-circulation of humus tank effluent.

A point of interest that arises here as a result of a request for information is that in Great Britain, where towns are sewered on the combined system (surface water and foul water in the same drain) a sewage treatment plant is usually designed to fully treat all flows up to three times the normal dry weather flow. Consequently, where settling tank capacities appear to be unusually large, it should be remembered that these same tanks must be capable of giving adequate settlement to these much larger storm flows.

Basic Principles of Detergency

Why Synthetic Detergents Reduce the Efficiency of Sewage Sedimentation

by ROLF ELIASSEN, *Prof., San. Eng., Mass. Inst., Technology, Cambridge, Mass.*

BORN of the ingenuity of research chemists only twenty years ago, synthetic detergents have been considered among the most successful developments in chemical technology in recent years. Produced by chemical engineers and "plugged" incessantly by soap-operas and multi-million dollar advertising budgets, the brand-names of Tide, Dreft, Fab, Vel, Surf, and Breeze are fast becoming standard household words[1].

Housewives and industrial users have been so taken with the miraculous properties of synthetic detergents that in the past twenty years sales have climbed from nothing to approximately one billion pounds in 1950. The remarkable fact in this growth is that solid soap, in use for 2000 years, represented a consumption of only 2.3 billion pounds in 1950[2]. Increasing demand, together with developments through research, indicate further growth in the use of synthetic detergents for household and industrial cleansing purposes.

Soap

Soap is a detergent resulting from the reaction between animal and vegetable fats and caustic soda. A typical soap, sodium palmitate, is an aliphatic compound comprised of a long hydrocarbon chain ending in a sodium carboxylate group, as illustrated in Fig. 1. Soap has two distinct disadvantages. First, it reacts with the calcium and magnesium ions of hard waters to produce an insoluble precipitate. Second, in acid solutions, even though only slightly acid, soap will revert to a fatty acid and lose its powers of detergency.

Synthetic Detergents

These detergents are considered in three categories based on their ionization in water: anionic, cationic and non-ionic. Only the anionic need be considered as affecting sewage treatment plant operation because the use of anionic detergents far exceeds any others and thus would be the only ones of significance in municipal sewage.

A typical synthetic detergent of the anionic type is shown in Fig. 2. This is an alkyl sulfate. The similarity in its structure to that of soap will be apparent. Considering the long hydrocarbon chain as R, the principal difference lies in the part which ionizes. Thus, soap is R-COONa, while the synthetic is R-O-SO_3Na. In both, the sodium ion goes into solution, leaving the main part of the compound as an anion, negatively charged. Therefore, both of these are anionic detergents. Another group of synthetic detergents in common use is represented by sodium octyl naphthalene sulfonate, a typical sodium alkyl aryl sulfonate, illustrated in Fig. 3. This is somewhat similar to the other synthetic and will ionize in water with the larger ion, R_1-R_2-SO_3^-, negatively charged (anionic).

Properties of Detergents

By referring to the preceding figures, it will be noted that all of these detergent molecules have common features. A long hydrocarbon (R) chain predominates. This end of the detergent molecule is hydrophobic—antagonistic to water. The other end of the molecule,—COONa and—SO_3Na is hydrophilic—compatible with water. These two parts of the molecules are characteristic of all detergents and govern their powers of detergency.

When detergents are dissolved in water, the surface tension of the water is lowered to about one-half its normal value, depending on the nature and concentration of detergent. The lowered surface tension permits the water to spread more readily and thus wet a greater area. For example, on greasy surfaces, water will first form into droplets, but with detergent present will distribute itself over the surface. The ultimate of spreading water thin is in the formation of suds, possible only through lowered surface tension.

The hydrophobic portion of the detergent molecule tries to escape from the water and thus will associate with greases, fats, and other organic substances with which it is compatible. Thus the linkage between grease and water goes through the hydrophobic chain, through the hydrophilic portion to the water. This is shown in Fig. 4.

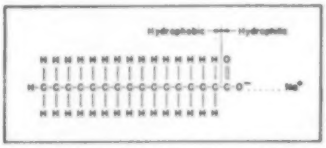

Fig. 1—Typical soap: sodium palmitate.

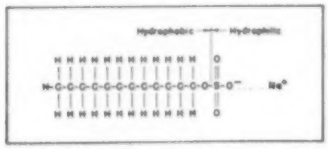

Fig. 2—Synthetic detergent: sodium dodecyl sulfate.

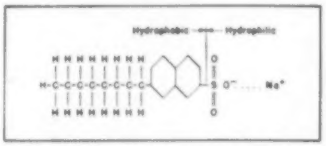

Fig. 3—Synthetic detergent: sodium octyl naphthalene sulfonate

To remove the grease and dirt from the object being cleansed, the grease and detergent must be suspended in water in relatively small particles—preferably as colloids, but not much larger in order to prevent settling out as sludge. This is accomplished by means of orientation of the ions of the detergent. The hydrophobic portions of the molecule are oriented toward the greasy particle while the charged hydrophilic portions are pointed away from it, as shown in Fig. 5. Thus, these dirt particles are completely encircled with a charged layer of detergent molecules. Myriads of similar particles exist in the same suspension and repel each other in a peptized state, thus preventing coagulation and settling.

This condition is similar to that existing in turbid water supplies which remain stable (peptized) until coagulation by means of chemicals is employed to neutralize the charges on the particles causing turbidity.

Effect on Sewage Sedimentation

With dirt kept in a stable suspension by the synthetic detergents, it is evident that settling will not be efficient. This is not true when the ordinary soap is used because the calcium and magnesium present in sewage will react with the soap and destroy its detergent properties through the formation of an insoluble precipitate. These spent soaps may rise as scum or settle with sludge.

Since synthetic detergents are not affected by calcium and magnesium, nothing in the sewage will cause them to lose their power of detergency and thus the dirt will continue to remain in suspension. Furthermore, the habits of American housewives in the lavish use of detergents means that an excess will pass to the sewers and probably suspend greases and other materials which would otherwise settle out in sedimentation tanks.

That such is the case has been reported by many sewage plant operators. Sperry[3] has published supporting data to show the decreasing efficiency of the plain sedimentation process (in the removal of B.O.D. and suspended solids) at Aurora, Ill., with increasing use of synthetic detergents by housewives.

Another serious difficulty arises from the lowered surface tension of the sewage in the formation of foam whenever aeration is employed, as described by Keefer[4] and Finch[5]. In the past, the precipitation of soap has usually increased the surface tension of sewage to the point where suds would not form. Since this is not the case with synthetic detergents, the formation of suds is encouraged and much trouble may result in the operation of aeration units.

The Search for Remedies

The ultimate answer to these problems of plant operation may be easily stated, but may be very difficult of achievement. If only the synthetic detergent industry could develop a cheap chemical to be fed into the

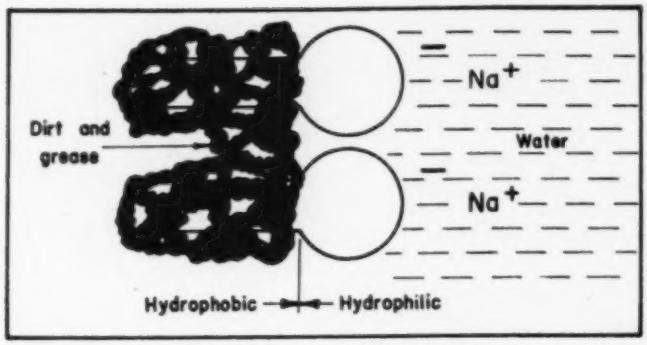

Fig. 4—Action of a synthetic detergent.

influent of sewage treatment plants to destroy the binding power of detergents on grease and dirt, the difficulties might be overcome. But the very stability which has sold housewives on synthetic detergents is the same stability which plagues sewage treatment plant operators. The detergent industry is very cognizant of this situation and can be depended upon for help in the problem.

Sanitary engineers are experienced in the removal of negatively charged colloids from water and sewage. The use of alum or ferric chloride will produce positively charged micelles which can accomplish flocculation of the detergent-bound particles. But the cost would be great because sewage plants are not usually equipped with coagulation tanks ahead of primary settling and the cost of chemicals is high.

Foaming can be controlled by the addition of anti-foam chemicals to the sewage—also a matter of expense. Spray nozzles have also been used to destroy foam; these require special installations and are an operating expense.

With the increasing pressure being put upon sewage treatment plant operators to improve the operation of their plants, the effect of synthetic detergents is a discouraging blow. A comprehensive program of research is called for at this time, particularly since the use of synthetic detergents will continue to increase.

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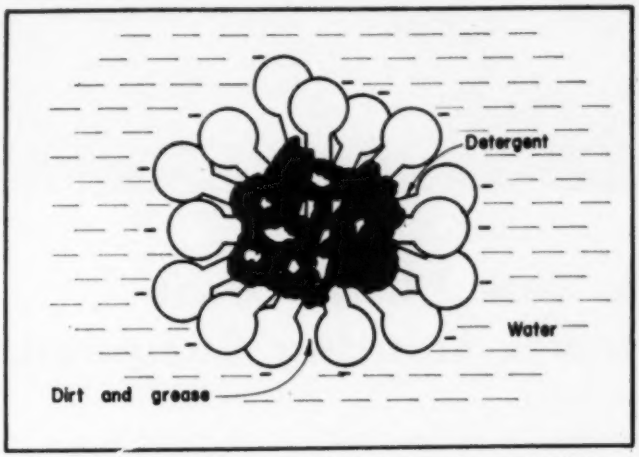


Fig. 5—Orientation of detergent molecules to form negative charged micelle.

Controlling Foam in Sewage and Waste Disposal

With the above title a new "Technical Memorandum" provides timely information concerning this increasingly important problem. One solution appears to be provided by the development of a new product Foamrex W, which is offered as a means of killing foam and inhibiting its formation at an economical concentration of 1 ppm.

The characteristics of this product are described, and simple means are suggested for its application. Effectiveness of the product has been largely demonstrated by applications in one large municipal sewage treatment plant, and is illustrated by a number of "before-and-after" photographs.

Excellent performance results in paper mill wastes, rubber reclaiming wastes, and pharmaceutical wastes are said to provide further evidence of its effectiveness for industrial waste applications.

If confronted with the foaming nuisance Socony's Technical Memo—"Controlling Foam in Sewage and Waste Disposal" may prove worth a lot to you. For a copy address "Foamrex," c/o Socony-Vacuum Oil Co., 26 Broadway, New York 4, N.Y.

A Much Needed Undertaking

The American Public Works Association and the Municipal Finance Officers' Association are to establish a joint committee which will undertake to develop standard cost units and improved cost accounting procedures for use by public works departments. There is hardly a more needed undertaking in the field of municipal business management than that of improvement in cost accounting. Especially is this true of sewage collection and treatment; and, to a lesser degree is it also true for water works operation and maintenance. What is most needed is a system which can be understood and put to use by those in charge of the smaller water and sewage systems. Perhaps this joint committee will be expanded to include representation from the American Water Works Association and the Federation of Sewage Works Association. At least we hope that there will be some participation from the field of Water and Sewage Works Management in the A.P.W.A.-M.F.O.A. undertaking.

W. O. Jones of Ft. Worth Named "Engineer of the Year"

The Fort Worth Chapter of the Texas Soc. of Professional Engrs. has named W. O. Jones, City Manager of Fort Worth, Texas, as "Engineer of the Year." The citation reads:

"Jones has shown that he is an engineer possessing the abilities of a top-flight executive, capable of the efficient management needed to give Fort Worth top-ranking municipal government during a period of unparalleled urban growth enjoyed by our city."

COMPARISON of joints after deflection test. New composition joint to right still tight after 15 degree deflection.

A New Plastic Base Sewer Jointing Compound

Developed in the Maximillian F. Wirtz Memorial Research Laboratories

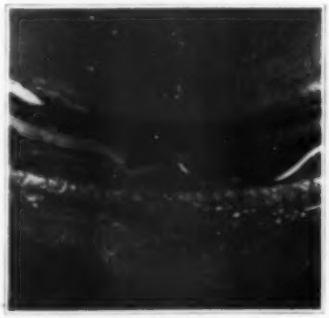
by RAYMOND B. SEYMOUR, WALTER R. PASCOE *and* ROBERT H. STEINER

The Atlas Mineral Products Company, Mertztown, Pa.

SEWERS constructed with vitrified clay pipe can approach perfection only if the jointing material is essentially as chemically resistant as the pipe itself and is sufficiently ductile to compensate for the inherent brittleness of the ceramic pipe. The research now to be reported was undertaken in order to develop a plastic-base sewer jointing compound which would meet most of the requirements for a perfect joining compound and to compare the properties of this product with other commercially available jointing compounds.

The techniques customarily employed for joining sewer pipe have been reviewed[1], specific directions for making good sewer joints have been published[2] and standards for a perfect jointing compound for sewer pipe have been suggested. According to York[3], a perfect joint should have the following properties:

(a) Permanent bond with the pipe under all conditions
(b) Freedom from bubbles and impurities
(c) Resistance to household wastes, cleaners, detergents and greases



FAILURE in the Thermal Shock Test. Note chipping and cracking of this particular hot poured compound.

(d) Sufficient flexibility to permit some movement of the pipeline resulting from settlement, etc.
(e) Quick-setting properties
(f) Sufficient strength to resist breakage of the joint in the trench
(g) Resistance to infiltration
(h) Simplified directions for use
(i) Economical advantages

Palmer[1] investigated a proprietary hot-poured filled asphalt compound and reported that properly poured joints of this product would not be penetrated by roots. However, House and Pomeroy[5] concluded that asphaltic compositions were not sufficiently root-resistant for use in warmer climates. They found hardness of the jointing material to be a major factor in determining root-resistance and stated that the ideal compound should also possess an adhesion of at least 200 psi. and should not crack when chilled. House and Pomeroy[5] published data on root-resistance and other properties of forty-five different formulations and selected a mineral-filled coal tar pitch composition as the overall best of the products studied.

From a practical point of view, in addition to the previously cited requirements, the joints should not crack, slump or lose adhesion under

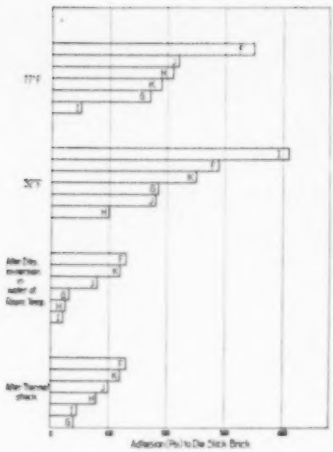


Fig. 1—Comparative adhesion of hot poured sewer jointing compounds to ceramic surfaces.

conditions simulating those expected during the construction of a pipeline and the properties of the compound should not be affected adversely by the melting process even after long periods of time. The resistance to cracking on a cold day could be tested by immersing a freshly poured joint in ice water and the resistance to slumping could be tested by measuring the slump resistance of 1" x 1" test bars supported between 2" centers at elevated temperatures. Any adverse effects of long periods of heating could be shown by comparative tests of the composition before and after the four hour heating period.

Development of a New Plastic Composition

A plastic base compound was developed by Manley[4] more than ten years ago. While it was undoubtedly the best that could be developed at that time, considering the raw materials then available, it did not resist heat deterioration or root penetration. In the investigation now to be reported all commercially available melt plastics were examined and a synthetic polycyclic hydrocarbon was selected as the most suitable material for further investigation. The principal compositions investigated are outlined in Table I and the significant properties as determined from the previously cited requirements for a perfect jointing material are compared in Table II. Although a large number of formulations were tested in order to establish the optimum amounts of each of the major components but data on the effect of these variables

Table I

Composition of Experimental Products

Comp'n.	Plastic	Plasticizer	Graded Aggregate	Suspension Agent
A	100			
B	90	10		
C	56	4	60	
D	65	5	25	7
E	20	5	70	7
F	30	5	60	7

Table II

A Comparison of Properties of Experimental Plastic Compositions

Property	A	B	C	D	E	F
Adhesion (psi) to brick						
@ 32 F.	10	150	250	75		290
@ 77 F.	100	180	330	230	*	350
after soaking	65	90	140	110		130
after thermal shock	100	35	125	120		130
Tensile Strength (psi)						
@ 77 F.	P	P	500	100	550	500
after thermal shock	V.P.**	V.P.**	490	140**	1**	490
Penetration (0.1 mm.)						
@ 32 F.	1	2	0	0.8	0	0
@ 77 F.	0.7	2	0	1.0	0	0
@ 115 F.	5	10	1	1.5	0.2	1
Penetration Index	−1.0	+1.0	−1.0	−1.0	+1.0	−1.0
Vicat	7	15+	0.5	2.5	0.4	0.7
Gilmore Penetration						
@ 77 F. (hrs.)	12	1.5	70	40	168+	73
@ 100 F. (hrs.)	.01	0.03	1.8	0.8	300	2
@ 130 F. (sec.)	15	1	57	190	1,800	58
@ 160 F. (sec.)	1.5	0.5	7	2	120	8
Slump Resistance of 8" bars (min.)						
@ 100 F.	Too Brittle	Too Brittle	255	75	1,440	270
@ 130 F.	"	"	60	30	120	60
@ 150 F.	"	"	32	23	66	32
Melt. Point (F) Ball & Ring	165	150	212	194	253	212
Shrinkage (%)	8.4	10.0	5.1	7.3	2.6	4.8
Ash (%)	0	0	60	25	70	60
Specific Gravity @ 77 F.	1.1	1.09	1.69	1.25	1.86	1.69

*Sample too viscous to wet ceramic surfaces.
**Composition chipped when cooled.

Table III

Effect of Plasticizer (B)* on Plastic Jointing Material

Property	None	Plasticizer Content 1%	3%	5%
Tensile Strength (psi)	500	385	40	25
Penetration				
@ 32 F.	0	0.5	2	5
@ 77 F.	0	0.5	2	5
@ 115 F.	1	3	11	25
Slump Resistance 8" bar (min.)				
@ 100 F.	270	75	15	6
@ 130 F.	60	30	12	3
@ 150 F.	32	20	7	2.5
@ 160 F.	24	11	3	1.5
Melting Point (F) Ball & Ring	212	205	182	165

*(B) Mercury No. 20 Lubricating Oil—Sun Oil Co.

Table IV

Adhesion of Plastic-Sewer Jointing Compound to Vitrified Clay Pipe

Conditions	Unglazed (psi)	Glazed (psi)
Unprimed	272	289
Plastic Primed	445	209
Wet Unprimed	106	100
Wet Plastic Primed	480	197
After Immersion Unprimed	251	162
After Immersion Asphalt Primed*	342	234

*Slightly higher results secured with plastic primed. As later shown, asphalt priming reduces root resistance also.

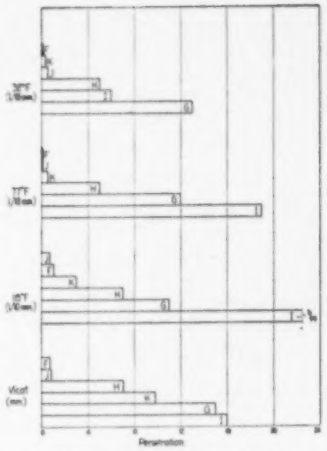


Fig. 2—Comparative penetration values for hot poured sewer jointing compounds under various conditions.

are omitted in the interest of brevity and clarity.

It may be concluded that the unfilled plastic was too brittle and was not adequate even when plasticized. The addition of filler increased the specific gravity, the softening point, adhesion and resistance to penetration and reduced shrinkage. However, even though the filler was carefully selected for particle size distribution, it would not remain in suspension in the molten state unless stirred almost continuously. In order to avoid possible changes in composition during use, a suspension agent which did not effect adversely the desirable properties was added. Composition F was chosen as the nearest approach to the previously cited requirements for a perfect jointing compound.

The Effect of Additional Plasticizer

While Composition F has sufficient ductility for practically all temperature conditions, its hardness can be decreased by the simple addition of a commercial lubricating oil as shown by data presented in Table III and plotted in Figures 1 and 2. The use of as much as 5% oil softens the product considerably and does not affect its adhesion or chemical resistance adversely.

Effect of Primer On Compo. F.

Everhart[5] found that the adhesion of Composition F to wet vitrified clay pipe was increased considerably by the use of a plastic base primer and as shown in Table IV, high adhesion values were also obtained after continued immersion in water.

Additional tests performed at the National Bureau of Standards[11] have

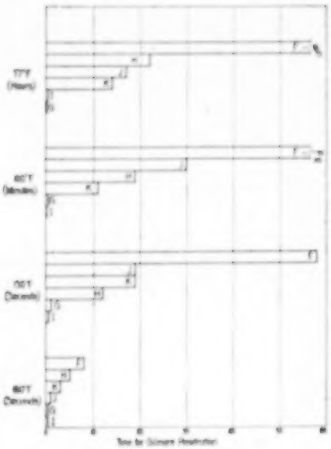


Fig. 3—Comparative pentration values with Gilmore Needle on hot-poured sewer jointing compounds.

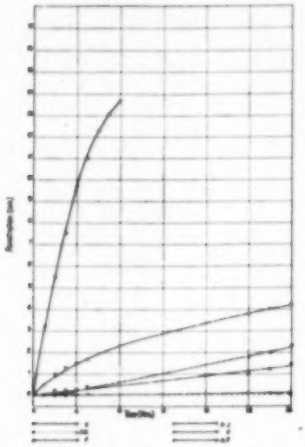


Fig. 4—Rate of penetration of 2000 g. Vicat Needle through hot poured sewer jointing compound.

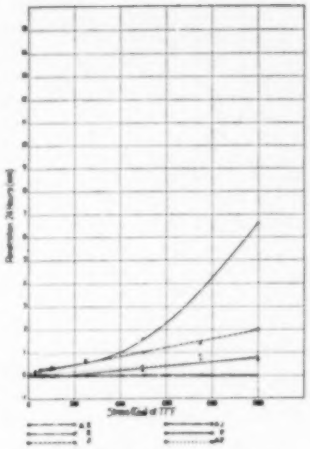


Fig. 5—Effects of stress on penetration of Vicat Needle through various sewer jointing compounds at 77° F.

shown that Composition F, when properly poured, produces a tight joint as strong as the pipe material itself.

Comparison of Proprietary Sewer Joining Compounds

The properties of the filled plastic Composition (F) were compared with commercially available filled asphalt (G), precast filled asphalt (H), filled coumarone-indene (I), filled coal tar pitch (J) and filled plasticized gel-type coal tar pitch (K) compositions.

All products tested were free from bubbles, had water absorption values of less than 0.3% and were resistant to weak alkalies, acids, and detergents. All except the asphalt compounds were resistant to vegetable oils.

A critical examination of the data in Table V, the more import of which is plotted in Figs. 1, 2 and 3, shows that the hot-poured filled asphalt (G) has low tensile strength, is soft and has a tendency to slump at elevated temperatures. The pre-cast filled asphalt composition (H) has excellent resistance to slumping at elevated temperatures but is not hard enough to meet previously cited requirements in respect to root resistance, as will appear later. The filled coumarone-indene composition (I) has low resistance to slumping but is not sufficiently hard to resist root growth. The filled coal tar pitch product (J) appears to be sufficiently hard but its adhesion to ceramic structures is reduced considerably by immersion in water and cooling. The plasticized gel-type filled coal tar pitch (K) has excellent ductility but does not appear to possess the required degree of root resistance. Both coal tar products bubble and chip when alternately warmed and cooled and may present a potential hazard to workmen because of the presence of volatile coal tar derivatives[3]. However, since the filled coal tar compositions (J and K) are apparently much closer to perfect materials than other proprietary materials studied, these were used as a basis for comparison with the experimental plastic Composition F.

Table V

A Comparison of Properties of Proprietary Sewer Jointing Compounds

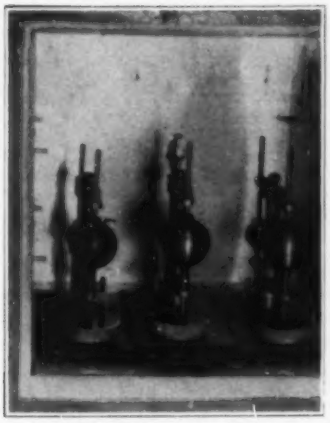
Property	Filled Plastic Comp'n. (F)	Filled Asphalt (G)	Pre-Cast Filled Asphalt (H)	Filled Coumar. Indene (I)	Filled Coal Tar Pitch (J)	Filled Plasticized C.T. Pitch (K)
Adh. to glazed pipe	V.G.	E	F-P	V.G.	P	P
Adhesion to brick						
@ 32 F. (psi)	290	185*	100	410	180	250
@ 77 F. (psi)	350	170*	210	50*	220	190
after soaking	130	80	25	20	80	120
after therm. shock	130	40	80	45**	100**	120**
Tensile Strength (psi)						
@ 77 F.	500	50*	125*	0*	260	200*
after therm. shock	400	40*	120*	0*	400	250
Penetration						
@ 32 F.	0	13	5	6	0.5	0.5
@ 77 F.	0	12	5	19	0	0.5
@ 115 F.	1	11	7	99	0.7	3
Penetration Index	−1.0	+5.0	+4.5	+2.0	−1.5	+1
Vicat	0.7	15+	7	15+	0.75	9.8
Gilmore Penetration						
@ 77 F. (hrs.)	73	0.13	22	0.35	17	14
@ 100 F. (hrs.)	2	0.5	0.3	0.005	0.5	12
@ 130 F. (sec.)	58	1	12	0.5	19	19
@ 160 F. (sec.)	8	0.5	5	0.5	1	3
Slump Resistance of 8" bars (min.)						
@ 100 F.	270	25	2,760	0.6	210	5,000+
@ 130 F.	60	80	120	0.006	30	84
@ 150 F.	32	25	50	0.4	29	1
@ 160 F.	24	22	46	0.3	20	42
Melting Point (F) Ball & Ring	212	246	260	176	195	226
Shrinkage (%)	5.1	6.3	6.2	4.5	5.6	5.3
Ash (%)	60	50	50	72	24	32
Spec. Gravity @ 77 F.	1.69	1.51	1.48	1.74	1.48	1.56

(+ signs signify values higher than those recorded.)
Legend: (E)—Excellent (P)—Poor (F)—Fair (V.G.)—Very Good

*Stretched
**Chipped when alternately cooled and warmed

The Effect of Long Term Heating

Asphalt and coal tar pitch are mixtures of many different compounds[3] and are fairly readily decomposed by heating at pouring temperatures for relatively short periods of time. A previous investigation[10] has shown heat stability of hydrocarbon plastics to be a function of their structure and



GILMORE Needle set up in 100 degree test oven.

theoretical study of the synthetic polycyclic hydrocarbon chosen for this investigation has indicated that it is considerably more heat stable than materials used previously for jointing compounds. This effect might also be predicted from flash and flame point data, since the flash point of the filled plastic material is almost 200°F. above the flash point of the filled coal tar pitch composition.

As is evident by data presented in Table VI, this observation has been substantiated by practical measurements. Filled coumarone-indene compositions could not be heated above 400°F. without considerable change in properties, while the plastic composition chosen for this investigation did not appear to decompose to any great extent after ten hours of heating at 500°F. The effect of ten hours heating of the coal tar pitch products at 464°F. and the plastic composition at 500°F. was compared. It may be concluded that under practical job conditions, the heated plastic compound (F) would be essentially unchanged by long time heating on the job, whereas the properties of the coal tar product would be affected adversely under normal conditions of use. The plasticized gel-type composition (K) is quite ductile but this property is completely lost after 6 hrs. of heating at 400°F.

Root Penetration

As previously pointed out by House[5], hardness plays an important part in preventing the penetration of roots directly through the jointing material itself. This resistance, as measured by hardness, decreases as the temperature increases. Palmer[7] found that asphalt compositions were resistant to root penetration in Southern Canada yet proprietary products based on asphalt are known to be penetrated by roots in southern climates.

Obviously, a study of the mechanism of root penetration lacks significance unless one is assured that the resistance to root penetration at the interface of pipe and jointing compound is at least as great as that of the compound itself. Thus, any adhesive used, should preferably be based on a solution of the jointing material itself and effective adhesion must be maintained above a specific limit under all conditions normally encountered on the inside and the outside of sewer lines. The data previously presented[8] show that the actual adhesion in a primed or unprimed joint of the filled plastic composition (F) should be adequate.

Table VI

THE EFFECT OF LONG-TERM HEATING ON JOINTING COMPOSITIONS

Property after heating	J	K	F
Penetration			
@ 32 F.	0	0	0
@ 77 F.	0	0	0
@ 115 F.	0	0	0.5
Vicat	0	0	0.3
Gilmore Penetration			
@ 77 F. (hrs.)	168	168	100
@ 100 F. (hrs.)	100	100	2
@ 130 F. (sec.)	25,000+	25,000+	540
@ 160 F. (sec.)	12,000+	12,000+	28
Slump Resistance of 8" bars (min.)			
@ 100 F.	30+	30+	6
@ 130 F.	20+	20+	1
@ 150 F.	210+	210	35
@ 160 F.	190+	190	28
Melting Point (F) Ball & Ring	290+	234	216
Ash (%)	35	27	60
Spec. Gravity @ 77 F.	1.62	1.53	1.69

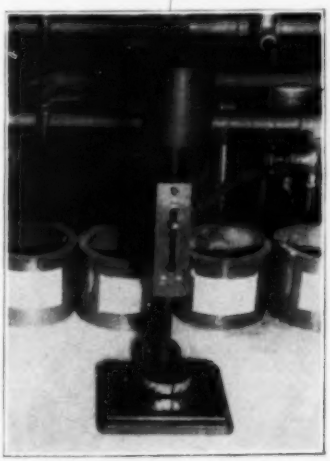
(+ signs signify values higher than those recorded)

Table VII

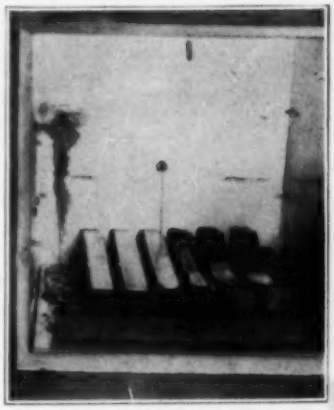
RATE OF PENETRATION AT 77°F. OF A 2,000 g. VICAT NEEDLE IN JOINT COMPOSITIONS

Composition	Penetration (mm.) Within Period Indicated 1 hr.	3 hrs.	6 hrs.	20 hrs.	24 hrs.
J	0.5	1.3	1.7	3.8	4.2
J htd. 2 hrs.	0	0	0	0.1	0.1
K	3.2	7.5	11.0	*	
K htd. 2 hrs.	0	0	0	0	0
F	0	0.2	0.4	1	1.4
F htd. 6 hrs.	0	0.2	0.4	2	2.2

*A penetration of 13.7 was recorded after seven hours.



VICAT Penetration Test with 2000 g. weight and compound at temperature of 77-F.



SLUMP Test with 8" bars. Note marked slump of joint compound bars on right.

While hardness of the joint itself is significant, *effective* hardness is of utmost importance. It should be possible to ascertain effective hardness or threshold resistance to root penetration through long time penetration studies which are more important than standard penetration values.

The time for a definite weight to penetrate a specific distance such as the previously reported Gilmore penetrations should not be disregarded. However, the rate of penetration of a 2,000 g. weight applied to a 2mm. needle at 77°F., as shown in Table VII and Fig. 4, would appear to be of greater importance.

The dynamic force exerted by a root has not been determined but it would probably be considerably less than 50 psi. However, as shown by the data in Table VII and Fig. 4, a constant stress of 2,000 g. on a 2 mm. needle (approximately 1600 psi) would require approximately one day for the complete penetration of a 1" thick joint of K, 6 days for J and 12 days for F. Practical root penetration tests, discussed later in this report, indicate that the force exerted by roots of corn was somewhat less than 50 psi and hence F should be satisfactory for root resistance regardless of how long the material was heated on the job. The root resistance of J and K after 2 hrs. heating would

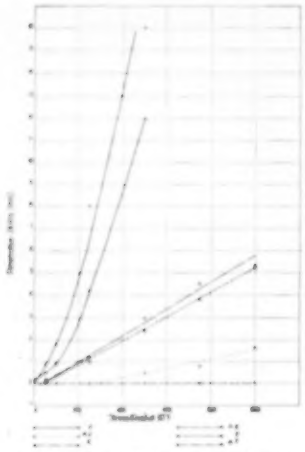


Fig. 6—Effects of stress on penetration of Vicat Needle through various sewer jointing compounds at 90° F.

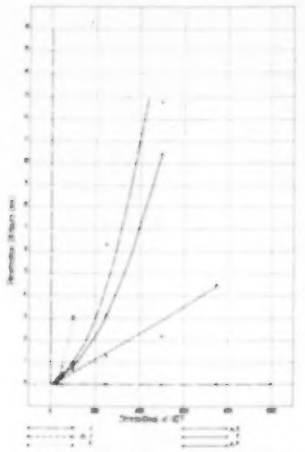


Fig. 7—Effects of stress on penetration of Vicat Needle through various sewer jointing compounds at 100° F.

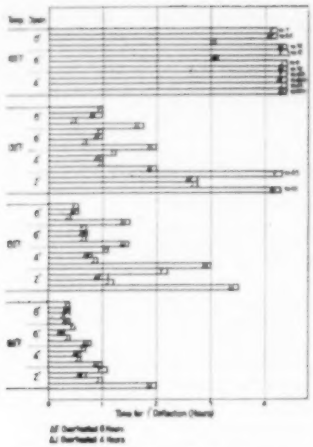


Fig. 8—Comparative effects of overheating on slump resistance of coal tar and plastic base jointing compounds.

be satisfactory except as previously noted, the heated product would not have sufficient adhesion to the pipe itself.

Since the temperature in lines in southern climates might be expected to be above 77°F., additional tests were run at 90 and 100°F. In these tests, the effect of increase in stress on penetration was also studied. The data are outlined in Table VIII and plotted in Figs. 5, 6 and 7.

If one assumes that the maximum force exerted by a root is 50 psi, then the force of a 100 g. weight exerted on a 2 mm. Vicat needle at various temperatures would be of utmost significance. Likewise, it may be of interest to note that a penetration of 1 mm. in 24 hrs. would be equivalent to about 1" a month. If the above assumptions were correct, then a material would be satisfactory for root resistance, providing the penetration of a 100 g. weight on a 2 mm. Vicat needle over a period of 24 hrs. was not greater than 1 mm. Likewise, the product should not yield abnormally to increasing stress but should have a constant rate of increase in penetration with increased load. A critical examination of the tabulated and plotted data will show that Composition F meets the theoretical requirements for root resistance at 77, 90 and 100°F. whereas effective root resistance of J and K at 90 and 100°F. is open to question.

Table IX

Comparative Root Resistant Data

Composition	Frequency (%) of Root Penetration At the Ceramic Interface (1 mo.)	Through the Compound (2 mo.)	(0.5 mo.)	(1 mo.)
G	50	100		
G after 4 hrs heating	100	100		
H	75		100	
J	40		0	100
J overheated	0		100	
F glazed pipe	0	0	0	100
F unglazed pipe	0	0	0	50
F asphalt primed	0	0	0	100
F plastic primed	0	0	0	75
F overheated	0	0	0	0

Practical Root Resistance Tests

The theoretical observations on Vicat penetrations were checked and substantiated by actual tests of root resistance. A preliminary series of root tests using eucalyptus seedlings at Houston, Texas, indicated that Composition F was outstanding in its root resistance and more precise test data were obtained in northern summer climate using corn seedlings. Four root tests were made for each composition under each set of conditions.

As shown in Table IX, the asphalt compositions (G & H) proved completely inadequate. The filled coal tar pitch (J) showed promise when not overheated but the unprimed plastic composition (F), or (F) primed with a similar plastic material, was the most root resistant product tested.

Table VIII

One Day Penetration (mm.) of Vicat Needle Under Various Loads at Various Temperature

Comp'n.	30 g.	50 g.	100 g.	250 g.	500 g.	750 g.	1,000 g.
(At Temp. of 77° F.)							
J	0.2	0.3	0.5	0.6	1.0	1.4	2.0
J Htd. 2 hrs.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K	0.0	0.3	0.4	0.7	1.6	—	6.6
K Htd. 2 hrs.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F	0.0	0.0	0.0	0.1	0.2	0.7	0.8
F Htd. 6 hrs.	0.0	0.0	0.1	0.2	0.4	0.9	0.7
(At Temp. of 90° F.)							
J	0.0	0.9	1.8	8.0	16.0	20+	
J Htd. 2 hrs.	0.0	0.0	0.0	0.0	0.5	0.8	1.6
K		0.5	0.9	4.2	12.0	20+	
K Htd. 2 hrs.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F	0.0	0.1	0.4	1.0	2.4	3.8	5.3
F Htd. 6 hrs.	0.0	0.2	0.4	1.2	3.0	4.5	5.2
(At Temp. of 100° F.)							
J	20+	20+					
J Htd. 2 hrs.	0.0	0.4	0.2	1.5	2.5	4.5	
K	0.2	0.8	3.1	20+			
K Htd. 2 hrs.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F	0.0	0.5	0.9	3.1	10.4		
F Htd. 6 hrs.	0.1	0.3	3.0	6.3	12.8		20+

(+ signs signify values higher than those recorded.)

Effect of Thermal Shock

In order to ascertain that joints made from hard material such as compositions (F) and (J) would not fail as a result of rapid cooling such as might be expected with pipe line construction in cold weather, 4" and 8" glazed vitrified clay pipe were joined and then plunged into ice water at 32-36° F. and allowed to remain for a period of 2 hrs. Any tendency to leak was ascertained by subsequently plugging the ends of the pipe and attempting to fill with water. As shown in Table X, many of the coal tar joints leaked especially in the larger sized pipe. When the coal tar composition was heated for several hours and then poured, the joints

Table X

Effect of Thermal Shock on Sewer Joints

Material	Pipe Size	Frequency (%) of Failure Through Leakage*
J	4"	50
J	8"	75
J heated	8"	100 (cracked)
F	4"	0
F	8"	50
F heated	8"	0

*Four tests made for each set of conditions

cracked badly. However, both the freshly melted and long-time heated plastic type joint formed from Composition F appeared to be satisfactory in most instances.

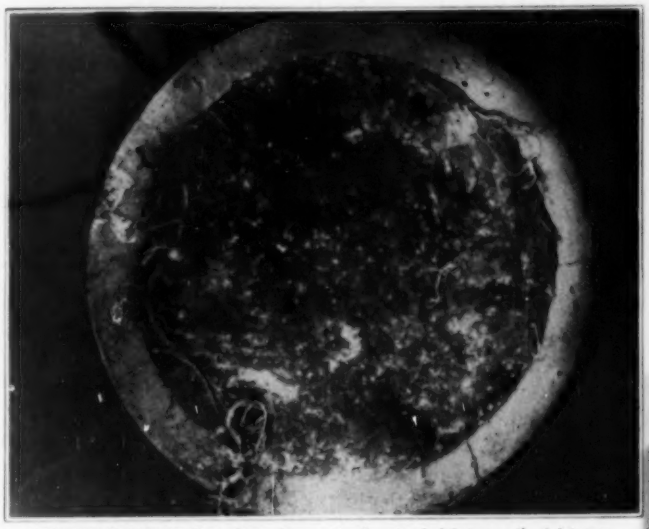
Deflection Under Load

Since it is not obvious that hard materials such as filled coal tar pitch or filled plastic compositions will deflect sufficiently to permit pipe lines to settle somewhat, a series of deflection tests were made. Wyly[9] applied a 50 lb. load to joints of Composition F in 4" pipe suspended on 4 foot centers and increased the load at the rate of 7 lbs. per min. Loads in the order of 500 lbs. and bending moments of 1,000 lbs./ft. were encountered before the pipe broke. The maximum deflection was 0.75" and there was no sign of water leakage before failure.

Tests were made during the development of Composition F using 4" pipe with 3 foot spans between centers under 50 lb. loads at 80°F. Under these conditions, a deflection of 5° was noted after 20 days and the joint did not fail as measured by its ability to hold water until a deflection of approximately 15° was reached. Both the coal tar pitch composition and the filled plastic Composition F exhibited sufficient plastic flow at 60, 70 and 80°F. However, as previously pointed out, the former produced rigid joints when it was heated for a period of several hours before use.

Effect of Temperature on Slumping

Pipe lines may be exposed to the hot sun before back-filling or may carry warm sewage. Therefore, it is important to know the effect of temperature on slumping of the jointing material itself. This effect was determined by supporting 1" x 1" bars with various spans at different temperatures and measuring the time for the center to deflect 1 inch. The data tabulated in Table XI, and plotted in Fig. 8, show the resistance to slump is an inverse function of the length of the span and proportional to the temperature. Long time heating has little effect on the slump resistance of Composition F but reduces the plastic flow of Compositions J and K tremendously.



ROOT PENETRATION Test. Roots have not only extended between the joint compound and pipe wall but some actually penetrated this asphalt base compound.

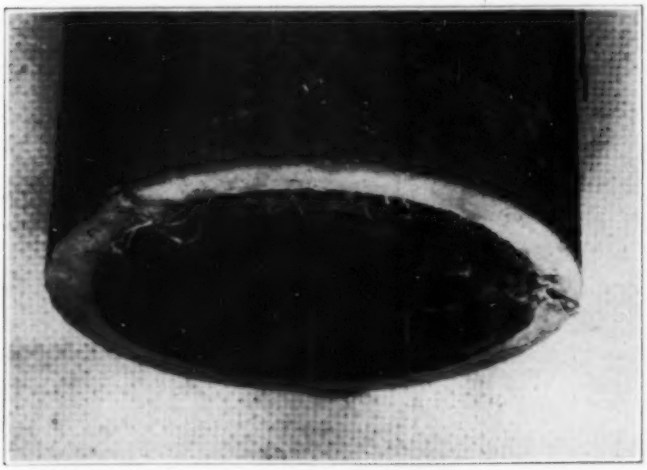
Table XI

EFFECT OF TEMPERATURE ON SLUMPING

Compo.	Span (In.)	Time (hrs.) at Various Temperatures 100 F.	130 F.	150 F.	160 F.
F	8	7+	1	0.75	0.4
	6	12	1	0.7	0.5
	4	165+	1.25	1.3	0.7
	2	———	6.5	2.2	1.1
F heated 6 hrs.	8	5.2	1	0.75	0.4
	6	5.3	0.6	0.75	0.3
	4	200+	1	0.8	0.6
	2	———	2.75	1.1	0.7
J	8	3.5	0.5	0.5	0.3
	6	6	0.7	0.7	0.4
	4	45	1	0.9	0.6
	2	———	2.7+	1.2	1
J heated 4 hrs.	8	22	1.75	1.5	0.4
	6	72+	2	1.5	0.8
	4	200+	2.5	3	1.3
	2	———	10+	3.5	2

(+ signs signify values higher than those recorded.)

In spite of the resistance of Composition F to slumping, it should not be considered as a slip-type joint material since the slump resistance of Composition H is very much superior for this purpose.



ROOT PENETRATION Test. Roots here forced coal-tar base jointing compound to separate from ceramic pipe wall.

Description of Tests

Adhesion to Glazed Clay Pipe:

A small amount of molten material was poured on the outside of vitrified clay pipe and the adhesion before and after thermal shock was determined qualitatively.

Adhesion to Die Slick Brick Surface:

Half figure eight dense bricks were joined with various molten compositions and the adhesion was determined after 24 hrs. in air, after 24 hrs. immersion in water and after thermal shock using a Dillon tester. The specimen was pulled at a rate of ¼" per min. at 77°F. Soft compositions exhibited plastic flow and hence did not give true values.

Thermal Shock:

Die slick brick joined with various compositions, steel panels with 20 mil. coatings, figure eight tensile specimens and ½" thick cast rings measuring 5" O.D. and 2" I.D. were placed alternately in water at 150°F.

EXHIBIT of root penetration test specimen. Corn roots penetrated this coal-tar base compound.

and 50°F. for 2 min. each and this test was repeated for 20 cycles.

Four 8" glazed vitrified pipe were joined with hot compositions, allowed to cool to room temperature, and immediately plunged into ice water at 32.36°F. After 2 hrs., the pipes were removed, the bottoms sealed and the ability of the joint to hold water was tested by filling the pipes with water in a vertical position.

Water Absorption:

Coupons measuring 1" x 1" x ⅛" were immersed in water for four days and change in weight was measured.

Chemical Resistance[11]:

Coupons measuring 1" x 1" x ⅛" were immersed in the various test liquids for definite periods of time and their change in weight was observed in accordance with published technique.[11]

Tensile Strength:

Figure eight briquettes of the products were broken on a Dillon tester before and after thermal shock by pulling at a rate of ¼" per min. at 77°F. Soft compositions exhibited plastic flow and hence low tensile strength values were obtained.

Penetration:

A.S.T.M. D 5-25.

Penetration Index[8]:

A value deduced by plotting log penetration vs. temperature as follows:

$$\left[\frac{\text{d log pen.}}{\text{dT}}\right] = \left[\frac{20 - \text{PI}}{10 + \text{pI}} \times \frac{1}{50}\right]$$

Vicat Penetration:

The penetration in mm. was measured for a 2 mm. diameter needle under a load of 2,000 g. for 1 hr. to 24 hrs. at 77°F. The rate of penetration for 24 hrs. under loads varying from 30 — 1,000 g. at 77, 90 and 100°F. was also measured.

Gilmore Penetration:

The time for penetration to the shank of a large Gilmore needle was measured.

Slump Resistance:

1" x 1" specimens were supported between 8", 6", 4" and 2" centers and the time for the center to slump 1 inch at various temperatures was recorded.

Melting Point:

A.S.T.M. E 28-42T

% Ash:

A.S.T.M. D 1010—49T

Specific Gravity at 77°F:

A.S.T.M. D 71-27

Deflection Tests:

Joined pipe were supported between 3 ft. centers. Weights were hung at the center of the span and deflection was measured at various intervals of time until failure was noted by the inability of the joint to hold water.

Resistance to Separation of Filler:

The residue deposited after twenty minutes heating at 220°C. in the absence of stirring was determined qualitatively.

Flash and Fire Point:

A.S.T.M. D 92-46

Effect of Long Time Heating:

The compositions were melted in the usual way and heated for periods of 2, 4, 6, 8 and 10 hrs. at elevated temperatures. The coal tar pitch products were heated at 464°F., while the plastic base composition was heated at 500°F.

Root Penetration Tests:

Sections of 4" drain tile were completely sealed with a ½" thickness of hot-poured jointing composition and then filled within 1" of the top with loam. Four kernels of corn previously treated with a root hormone were planted and the resulting seedings were allowed to grow for 2 months at summer temperatures ranging from 48 — 102°F. with a mean temperature of 75°F. The bottoms of the specimens were examined weekly to observe root penetration. All samples were broken after 2 months to determine the path of root attack if any—see pictures.

Acknowledgment

In the preparation of this paper the assistance of A. L. Moser, C. F. DeLong, L. Frederick and J. D. Fenstermacher is gratefully appreciated.

EXHIBIT of root penetration test specimen. No penetration of plastic base Compound "F" at any point.

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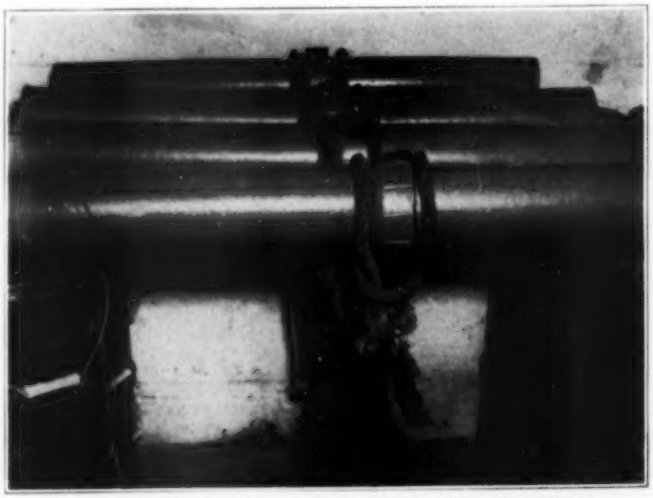

DEFLECTION Tests using 50-pound weights swung to joints midway of span.

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May 4-9—Kansas City, Mo. *(Municipal Auditorium)*
AMERICAN WATER WORKS ASSOCIATION (Annual Convention). Exec.-Sec'y, Harry E. Jordan, 521 Fifth Avenue, New York 17, N.Y.
(Accommodations in 14 hotels. Reservations through A.W.W.A. office.)

May 7-9—Lafayette, Ind. *(Purdue Memorial Union)*
7TH PURDUE INDUSTRIAL WASTE CONFERENCE. Director, Prof. Don E. Bloodgood, Purdue University, Lafayette, Ind.

May 12-13—Roanoke, Va. *(Hotel Roanoke)*
VIRGINIA INDUSTRIAL WASTES & SEWAGE WORKS ASSN. Sec'y, G. R. Talcott, 815 E. Franklin St., Richmond 19, Va.

May 15—Hanover, N.H. *(Dartmouth College)*
NEW ENGLAND WATER WORKS ASSOCIATION. Sec'y, Jos. C. Knox, 204 Tremont Building, Boston, Mass.

May 19-21—Traverse City, Mich. *(Park Place Hotel)*
MICHIGAN SEWAGE & INDUSTRIAL WASTES ASSN. Sec'y, D. M. Pierce, Room 334 Administration Bldg., Lansing, Mich.

May 21-23—Toledo, Ohio *(Commodore Perry Hotel)*
OHIO SEWAGE & INDUSTRIAL WASTES TREATMENT CONFERENCE. Sec'y, J. E. Richards, 301 Ohio Depts. Bldg., Columbus 15, Ohio.

May 22-23—Waterbury, Conn. *(Hotel Elton)*
NEW ENGLAND SEWAGE & INDUSTRIAL WASTES ASSN. Sec'y, Walter E. Merrill, State Dept. of Health, 511A State House, Boston, Mass.

May 26-28—Montreal, Canada *(Hotel Mt. Royal)*
CANADIAN SECTION A.W.W.A. Sec'y, Dr. A. E. Berry, Ontario Dept. of Health, Parliament Building, Toronto, Ont.

June 4-6—Auburn, Ala. *(Pitts Hotel)*
ALABAMA WATER & SEWAGE ASSOCIATION. Sec'y, Alex O. Taylor, Box 69, Alabama Polytechnic Institute, Auburn, Ala.

June 11—Houlton, Maine
MAINE WATER UTILITIES ASSOCIATION. Sec'y, Earle A. Tarr, Winthrop Water District, Winthrop, Me.

June 12—Portsmouth, N.H. *(Hotel Wentworth-by-the-Sea)*
NEW ENGLAND WATER WORKS ASSOCIATION. (June Conference) Sec'y, Jos. C. Knox, 204 Tremont Building, Boston, Mass.

June 18—Amherst, Mass. *(University of Massachusetts)*
THE MASSACHUSETTS WATER WORKS ASSN. Sec'y, Thomas E. Kennedy, Supt. Water Dept., Fitchburg, Mass.

June 18-20—Erie, Pa. *(Lawrence Hotel)*
PENNSYLVANIA SECTION A.W.W.A. Sec'y, L. S. Morgan, State Dept. of Health, Greensburg, Pa.

June 25—Martinsville, N.J. *(Martinsville Inn)*
NEW JERSEY SECTION A.W.W.A. (Summer Outing). Luncheon at Inn, Inspection of Elizabethtown's Millstone-Raritan Filter Plant. Sec'y, C. B. Tygert, Box 178, Newark, N.J.

June 25-27—Madison, Wis. *(Loraine Hotel)*
CENTRAL STATES SEWAGE & INDUSTRIAL WASTES ASSN. Sec'y, A. Paul Troemper, State Dept. of Health, Springfield, Ill.

Aug. 13—Machias, Maine.
MAINE WATER UTILITIES ASSOCIATION. Earle A. Tarr, Winthrop Water District, Winthrop, Me.

Aug. 24-27—Los Angeles, Calif. *(Shrine Convention Hall & Ambassador Hotel)*
AMERICAN PUBLIC WORKS ASSOCIATION. (Congress & Equipment Show) Exec.-Dir., D. F. Herrick, 1313 East 60th St., Chicago 37, Ill.

Aug. 25-27—State College, Pa. *(Nittany Lion Inn)*
PENNSYLVANIA WATER WORKS OPERATORS ASSN. Sec'y, R. Rupert Kountz, Pennsylvania State College, State College, Pa.

Aug. 27-29—State College, Pa. *(Nittany Lion Inn)*
PENNSYLVANIA SEWAGE & INDUSTRIAL WASTES ASSN. Sec'y, B. S. Bush, Dept. of Health, Kirby Health Center, Wilkes-Barre, Pa.

Sept. 3-5—Upper Saranac, N.Y. *(Saranac Inn)*
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Sept. 8-10—Groton, Conn. *(Hotel Griswold)*
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Sept. 3-13—Chicago, Ill. *(Conrad Hilton)*
AMERICAN SOCIETY OF CIVIL ENGINEERS. (Centennial Celebration). Sec'y, Wm. N. Carey, 33 West 39th St., New York, N.Y.

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IOWA SEWAGE WORKS ASSOCIATION. Sec'y, Leo Holtkamp, Box 310, Webster City, Iowa.

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Sept. 15-17—Knoxville, Tenn. *(Andrew Johnson Hotel)*
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Sept. 16-18—Madison, Wis. *(Hotel Loraine)*
WISCONSIN SECTION A.W.W.A. Sec'y, L. A. Smith, City Hall, Madison 3, Wis.

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Oct. 12-15—Tulsa, Okla. *(Mayo Hotel)*
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(Continued on page 107A)

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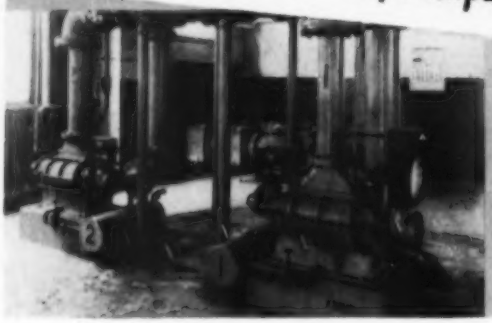

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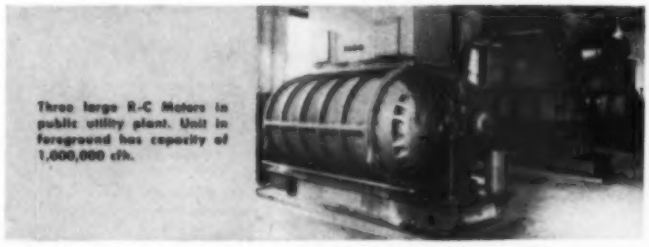

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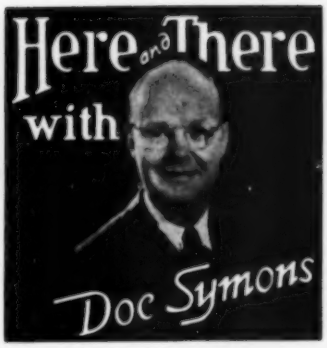

H.T.M.A.—And at the end of March as I sit here in my attic in Larchmont, I'm thinking what I'll wear at the Whooptedo party of the AWWA Convention in Kansas City, Mo.—*But*, by the time you read this, that party will be history and you'll be talking about what I did or did not wear, etc., and you'll no doubt be talking about the next AWWA Convention in Grand Rapids, Mich. in 1953.

I hope, too, that you'll be thinking and talking about the 25th annual convention of the Federation scheduled for Oct. 5-9 in New York City. Right now, I want to tell you that I am going to devote my whole September column to what you can see and do in New York City when you come to that Federation meeting in October.

* * *

Let's take care of some mail first—I. O. "Bert" Lacy, Supt. of Sew. Treat., Lockport, N.Y. writes, "On page 104A of the Feb. 1952 issue, you ran a story about the man who objected to the Erie Canal and who wrote a letter about it to the Editor of the *Niagara Sentinel* of Lewiston, N.Y.—Your story said the letter was dated Oct. 11, 1882; actually it was dated Oct. 11, 1822; that's 130, not 70 years ago."

* * *

Art Kuranz, Water Boy of Waukesha, Wis. writes that he hopes that some day I shall hear from all persons concerned with the several items that resulted from that one little error that appeared in my Sept. 1951 column. Incidentally, I saw Art in Chicago at the Ill. Sect. meeting, late in March. He tells me that if I want to see a real feud, to come to the Wisc. Sect. meeting, where Harold Londo (Green Bay Supt.), Al Hintz (Oshkosh-B'Gosh), H. E. Skibbe, P. P. (pipe peddler for James B. Clow), Zenno Gorder (Dir. Pub. Wks., LaCrosse and Chair. of the Wisconsin AWWA Beanie Club), Ozzie Muegge, State San. Engr. and others try to outdo one another with

(*Continued on page* 80A)

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(Continued from page 78A)

the barbed words. Wonder who started the original quibble?

* * *

I had a very nice note in January from Sam Greeley, of Greeley and Hansen, Engrs. Had hoped to see him at the Ill. Sect. meeting in Chicago, but he didn't make it. I thought maybe I could convince him that after all of these years he should give that old raincoat of his to AWWA Prexy, Dr. Berry. "Bert" tried hard enough to get it for a long time.

* * *

Do you recall that on page 86A of the November 1951 issue of this column, I quoted a letter about the trials and tribulations of a water and sewage chemist in the field, where gold plated balance weights and calibrated measuring equipment is unheard of—and how this clever fellow improvised with Coke bottles, etc., etc., etc.?

At the time, I didn't know who wrote the letter (which had come to me from Dr. Heukelekian) but a little sleuthing has uncovered the fact that the peerless author is one "Bob" Logan, Asst. to Dr. "Tony" Fischer of the Dorr Co.—If you didn't read that masterpiece, I suggest you look it up now—and I'm glad to remove the cloak of anonymity from Mr. Logan.

* * *

BANQUET FRENCH—To continue our lesson—

allemande sauce—It's a yellow mess of flour, butter, meat stock, cream, egg yolks, and lemon juice.—Tastes better than it sounds.

angels on horseback—Oysters wound with bacon, broiled and served on toast.—It's not French, but I thought some one might be able to tell me where this name came from; I suspect a misplaced sense of direction on the part of the chef who concocted the name, if not the dish.

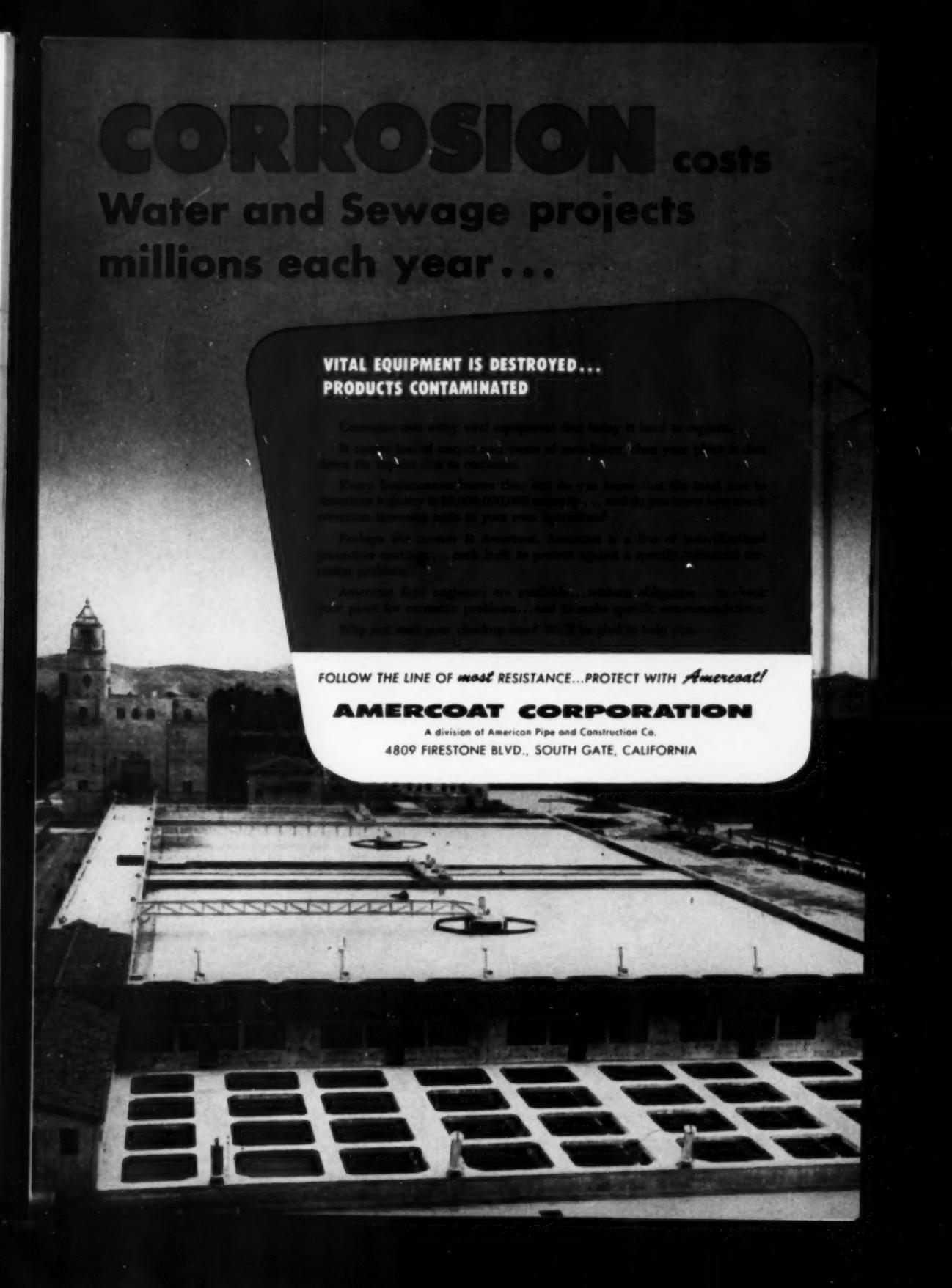
aniseed—A seed like fruit used as a fragrant, warm tasting condiment in candies and cookies—Also in Gin, liqueurs and licorice.

antipasto — (That's Italian, not French)—The first course of a meal consisting of assorted relishes, smoked or pickled meat or fish, etc. Most of us wouldn't know the difference between antipasto and Hors d'oeuvres.

aspic—(pronounced ass'pik)—a clear savory jelly used as a garnish or a carrier for meats, vegetables, fish or eggs. Usually made with tomato juice or V-8 and gelatin. Good, if you like that sort of stuff.

au gratin—Contrary to my early education, it is not a dish of vegetables sprinkled with grated cheese and

(Continued on page 82A)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SARAN RUBBER a DOW product

(Continued from page 80A)

baked—*But*—it is anything prepared with a top crust of grated bread, browned crisp—How wrong can you be?

au jus—(pronounced oh zhu')—Usually meat cooked in its natural juice or gravy, like for example roast beef—Mmmm—mm—mm—

au naturel—In its natural state, cooked simply—no herbs, no spices, no liquors. What?—No oo-la-la? Next month, we'll begin the B's.

* * *

You all know that one of my hobbies is collecting daffy definitions and one of my best sources has always been C. C. (The Swede) Larson of Springfield, Ill. Out of deference to and admiration of The Swede, I call my collection, "SWEDEFINITIONS."

Here's one that came from another Larson, Dr. T. A., who heads the Chem. Sect. of the Ill. State Water Survey under Dr. A. M. Buswell, with whom I once studied. Anyway here's Doc Larson's definition of—

Corrosion—"The logarithm of the reciprocal hydrogen ion activity provides a subsaturation of ferrous concentration in the fluid which results in the dissolution of the metal, accellerated by the conductive ionic concentration and by abnormal potential differences at certain locations as a result of and caused by diffusion, mobility, various side reactions and specific electrode reactions common in all electrochemical processes."

Now if some member of MU SAN will kindly forward me the definition of activated sludge, I shall feel educated.

* * *

By the way, I am also making a collection of Palindromes—If you have any please forward same.

* * *

At the NESWA meeting in Providence last November, Ralph Horne, Cons. Engr. of Boston, stepped into the elevator and said, "Ballroom." The elevator operator took him down to the first floor, where he asked the way to the ballroom and was told it was on the 15th floor. So Ralph stepped into an elevator—it was the same elevator—and said, "Ballroom, That's on the 15th floor."

The girl looked at him and said, "I thought you said BARroom."—He doesn't look like a drinking man!

* * *

Remember when I complimented Rupert Kountz, Civ. Engr. Prof. at Penn State and Secy. of the PaW-WOA, for using a large hand lettered

(Continued on page 86A)

Dependability in Power

U.S. VERTICLOSED MOTOR

STREAMWAY DESIGN FOR HIGHEST EFFICIENCY IN DEEP WELL PUMPING

Progressively improved for 44 years

PERFECTION IN MOTOR POWER

Forever Dependable

ASBESTOS-PROTECTED WINDINGS

DOWNDRAFT VENTILATION

ADJUSTABLE HOLLOWSHAFT

STREAMWAY DESIGN

VIS-O-LUBE OIL GAUGES

LUBRIFLUSH BEARINGS

US MOTORS

[U. S. Electrical Motors Inc.
Los Angeles 54, Calif. (Box 3088) Milford, Conn.
Send your 16-page Bulletin featuring
Verticlosed Motors for deep well pumps

NAME
COMPANY
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An Investment in Future Economy

Development of dependable power for deep well turbine pumps is notably reflected in the advanced U.S. Verticlosed Motor. Designed exclusively for pumps, this U.S. motor incorporates many exclusive features to insure high efficiency and prolonged life. Mail Coupon for 16-page descriptive Bulletin.

U. S. ELECTRICAL MOTORS Inc. Los Angeles 54, Calif. Milford, Conn.

U. S. VERTICLOSED MOTOR

You only dig once

WHEN YOU CLAMP WITH DRESSERS

Why pay for digging the same hole twice? Repeated repairs to leaking cast iron bell and spigot joints waste money. When you clamp with a Dresser Style 60 Bell-Joint Clamp, you fix it once and it's fixed for good.

The leak is effectively and permanently repaired.

Both the bell and the spigot ring of the Style 60 are adjustable to permit *exact* fit, even on offsize and foreign pipe. This positive adjustment to spigot and bell diameters assures the uniform sealing pressures required for a complete, lasting repair.

The Dresser Clamp also provides a *flexible* repair to protect against leaks should movement occur in the joint. The generous-size gasket extends well up the face of the bell to provide a suitable factor of safety.

Style 60's are ruggedly built for permanence. Millions are in use. Virtually every city in the country has discovered that it pays to "Fix it Once, Fix it for Good" with Dresser Style 60 Bell-Joint Clamps. Complete size range—3″ through 60″. Send your order today.

DRESSER

BELL-JOINT CLAMPS

Dresser Manufacturing Division, 59 Fisher Ave., Bradford, Pa. (One of the Dresser Industries). Warehouses: 1121 Rothwell St., Houston, Texas; 101 S. Bayshore Highway, South San Francisco, Calif.—Sales Offices: New York, Philadelphia, Chicago, Houston, South San Francisco. In Canada: 629 Adelaide St., W., Toronto.

(Continued from page 82A)

pocket identification card for convention registrants.

Carl Lauter of the Dalecarlia Water Plant in Washington, D.C. and Secy. of the Chesapeake Sect. AWWA reminds me that he has been doing that for several years and he sent me one he had made out for me for last year's meeting, which I missed. Can't we figure out some way, Carl, to get me down there this year.

And add another smart boy—Out at the Ill. Sect., late in March, section secretary Les (U.S. Pipe) Hart had pocket cards and a typewriter that prints in 24 point type. I'm all for that idea.—Nice to see you and Liz again, Les, and thank Oscar Gullans for inviting me to participate in your fluoridation panel.

* * *

It was at the Federation meeting in St. Paul last October, where I met A. M. (Tony) Trester, who remembered me as a high school boy when he was with the late and great "Danny" Meade of Madison, Wis. and "Tony" made a survey of the water works in Danville, Ill.—Mah old home town!

It was also at the Federation meeting luncheon when then president Ralph E. Fuhrman (Washington, D.C.) introduced Dr. A. E. (Bert) Berry, Dir. of San. Engr., Ontario, Can. Ministry of Health and Pres. of AWWA, and Ralph pointed out that Dr. Berry was the first man to ever be president of both the FSIWA and AWWA.—And a balding rusty haired columnist at one end of the room called out—"And he's a Canadian, too."

* * *

What's in a name?—Lou Howson, who is one of my very favorite persons, had an interesting experience in St. Paul at the Federation meeting. Lou wanted to talk to a fellow conventioneer but didn't know his room number, so he asked the hotel information and then gave the number to the telephone operator.

When a soft, sweet, southern voice answered, Lou was somewhat at a loss, for he was sure his friend's wife was not with him. What does one say under the circumstances? After a pause, Lou said, "Is Mr. Enslow there?" And the soft, sweet, southern voice said, "Not at the moment—" Lou was nonplussed—"but," the voice went on, "if you leave your number I'll have Porter call you."

Oh yes—the soft, sweet, southern voice belonged to Corley (Mrs. Van Porter) Enloe of Atlanta, Ga.

* * *

Before I run out of space—I want to say again that I shall devote my September column to a preview of New York City for those of you who are coming to the 25th annual meeting of the FSIWA, Oct. 5-9, 1952.

V.T.Y.—Doc.

Sturdy Oak

the STEEL of woods...

in all its natural beauty

For *your* laboratory—famous Kewaunee custom quality furniture in beautiful, long-lasting, natural finish oak. Oak—the *steel* of woods—for rugged service, long life. Oak—in natural finish—to brighten your laboratory, speed your work.

Specify oak—readily available—for durability and attractiveness. Specify Kewaunee—for finest custom quality, at extremely modest cost. Write today for a free copy of our catalog of Scientific Laboratory Equipment.

Representatives and sales offices in principal cities

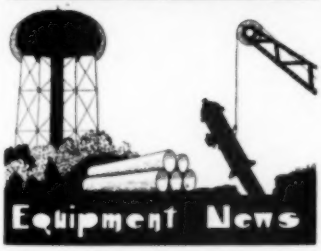
Kewaunee Mfg. Co.

J. A. Campbell, President

5102 S. Center Street • Adrian, Michigan

Manufacturers of Wood and Metal Laboratory Equipment

Manufacturers & Equipment News



"Versa-Table" Furniture Unit for Laboratories

501

Fisher Scientific Co., Pittsburgh, Pa., has announced that a new furniture unit, the Versa-Table, has been added to the line of Fisher Unitized Furniture.

(Continued on page 88A)

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

Accelator® *solves high color problem for Bradenton, Florida*

Remodeled plant designed by
C. K. S. Dodd, Engineer
Sarasota, Florida

2800 G.P.M. Accelator —with automatic chemical feeders and central control. Forced draft Aerator 8 Filters, 12x15 ft. Clarifies, filters, removes color, chlorinates and ammoniates up to 4 m.g.d.

Aerator **AFTER** *coagulation reduces CO_2 to 5 p.p.m.*

River water of high color (up to 400 p.p.m.) and low alkalinity (down to 8 p.p.m.) is cleaned and polished in this modern Infilco installation. Accelator clarification, followed by forced draft aerator, reduces CO_2 content to 5 p.p.m., produces bright, clear, non-corrosive effluent for final filtration.

CLEARER WATER FASTER with exclusive slurry recirculation
SAVE UP TO 80% IN SPACE (with lower construction costs)
SIMPLER OPERATION — mixing, coagulation, clarification and sludge removal all in one unit
FASTER CHEMICAL REACTION • HIGHER RATINGS

INFILCO
• BETTER WATER CONDITIONING • AND WASTE TREATMENT SINCE 1934

INFILCO INC. *Tucson, Arizona* | *Plants in Chicago & Joliet, Illinois*

FIELD ENGINEERING OFFICES IN 26 PRINCIPAL CITIES

World's Leading Manufacturers of Water Conditioning and Waste Treating Equipment

(Continued from page 86A)

The table is compact and will meet any laboratory's need for 30 by 48 inches of additional and unobstructed working space. It is claimed that as many as eight different methods of installation are possible to suit the existing or proposed physical layout of the laboratory.

Available with legs either 36 inches high or 30 inches high the tables are constructed of heavy gauge steel which can be topped with stainless steel, Kemrock, or Formica bonded to heavy plywood sections. In addition to working tops, reagent shelves may be had for the new unit. Two drawers conveniently hold those items used most by the laboratory worker while at the table.

Beckman Plans New Research Center

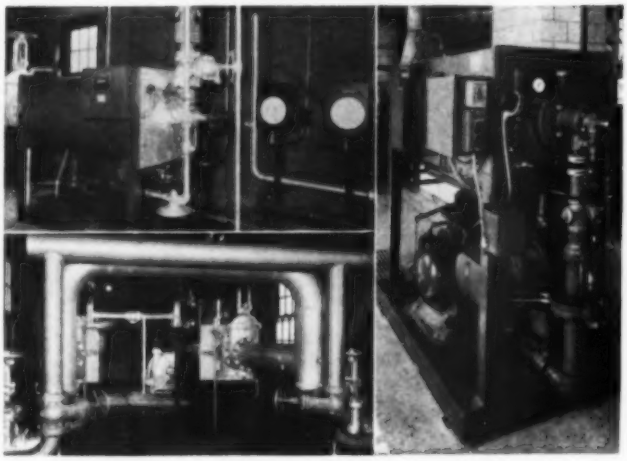
Beckman Instruments, Inc., South Pasadena, Calif., has announced the purchase of 40 acres in the Fullerton-La Habra area upon which will be built the most modern facilities in the West for the development and manufacture of precision instruments and advanced electronic equipment.

According to Dr. A. O. Beckman, President, this marks another important step in the growth of the Beckman companies to their present position in the development and manufacture of advanced research and industrial instruments.

CARBALL UNIT...

SPECIFICALLY DESIGNED FOR THE CLEAN, EFFICIENT CARBONIZATION OF LIQUIDS

92% TOTAL CHEMICAL EFFICIENCY



- A CO_2 producer that *COMPLETELY* burns GAS or OIL.
- Produces the highest percentage of CO_2 gas with no CO or condensible carbon.
- Completely eliminates oil scum . . . no taste imparted to potable waters.
- No scrubbers or filters required.
- Compressor handles clean, cold air only. The fuel is burned under sufficient pressure to cause deep diffusion directly from the producer.
- Diffuses CO_2 gas by efficient impingement diffuser, insuring 92% absorption and eliminating diffuser corrosion.
- A factory-tested, package unit with air compressor, fuel pumps and appurtenances.
- 50% more chemical efficiency than any other method in current practice.

To Reduce Costs and Modernize Your Plant:

WRITE FOR BULLETIN 7W64

WALKER PROCESS EQUIPMENT INC.

PROQUIP PROCESS EQUIPMENT

FACTORY • ENGINEERING OFFICES • LABORATORY

AURORA • ILLINOIS

L-P Gas Burner

Has Multiplicity of Uses

502

Joseph G. Pollard Co., Inc., New Hyde Park, N.Y., has available L-P Gas Burner Furnaces. The burner, designed by Goss Engineers, burns L-P Gas (Liquefied Petroleum), commonly known as "Bottled Gas." It is claimed to melt approximately 100 lbs. of lead or leadite in 10 minutes, and flame can be adjusted to maintain temperature.

Gas cylinders, which will operate the unit for many hours, are made of armor plate steel, equipped with relief valves and approved by Underwriters Laboratories.

With the attachment of a torch to the gas cylinder this unit can be used for sweating copper pipe fittings, drying pipe, thawing frozen pipe, and a multiplicity of other uses involving a torch flame.

M. D. Gilbert

Roy R. Bush

Rockwell Names District Sales Managers

Rockwell Manufacturing Co., Pittsburgh, Pa., has announced the appointments of M. D. Gilbert as Kansas City District Sales Manager and Roy R. Bush as Tulsa District Sales Manager.

Mr. Gilbert became affiliated with the Pittsburgh Meter Company in

(Continued on page 90A)

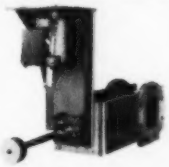
If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •

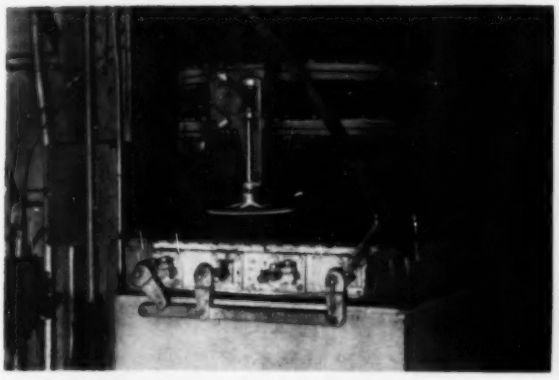
WATER SERVICE—No. 825—36-inch 125-pound cast iron valve equipped with 18—8 shafts, bronze bushings and rubber seat for 85-pound drip tight shut-off.

EMERGENCY OIL SERVICE—No. 628—solenoid trip valve. Should the solenoid function, the latch is tripped which causes the counter-weight to open or close the valve by gravity. Available in any metal or alloy and in various sizes for emergency shut-off or vent for air, gas, steam, oil, and water.



700° F. EXHAUST GAS SERVICE—No. 826—6-inch 125-pound R-S "H" metal valve used on small turbine generator. Equipped with 18—8 shafts, hastelloy bushings, finned lubricated stuffing box and solenoid trip mechanism.

STEAM SERVICE—No. 677—1500-pound welding end steel valve for superheated steam—A. S. M. E. Standards.



SEMI-SOLID SERVICE including abrasive and corrosive materials.

R-S VALVES
Control and Shut Off Practically Any Material

The beveled vane seats firmly at a 12½° angle and is closed from a fully open position through 77½° of arc by either manual or automatic operation. A metal-to-metal seat gives satisfactory commercial shut-off. When required, Monel or stainless steel can be welded to the vane periphery and a babbitted seat used in the valve body. Drip tight or bubble tight closure can be obtained with a rubber seat.

Power controlled prime movers delivering the necessary foot pounds of torque open or close these self-cleaning valves at any desired speed from one second to eight minutes according to requirements. Pressures range from 2 to 2500 psig and temperatures from minus 300° F. to plus 2000° F.

Such simplicity of design, adaptability and operating ease are the reasons why R-S Valves can be installed to control and shut off the volume and pressure of any material that flows or is forced through a pipe.

Obtain full details from your R-S representative.

R-S PRODUCTS CORPORATION
4600 Germantown Avenue, Philadelphia 44, Pa.
An S. Morgan Smith Company Subsidiary

DISTRICT OFFICES IN PRINCIPAL CITIES

(Continued from page 88A)

1924 as Sales Representative for Southern Texas. When the company merged and became the Pittsburgh Equitable Meter Division of Rockwell, he was assigned to the Houston District Office. In 1944 he was promoted to Tulsa District Sales Manager, a position he held until his recent appointment.

Mr. Bush studied engineering at the University of Oklahoma and was first affiliated with various drilling contractors and later the Texas Pipeline Company.

In 1934 Mr. Bush joined the Rockwell Sales Staff in the Tulsa area. He became Special Sales Representative for the company's Nordstrom Valve Division and in 1951 was appointed Sales Manager of the Oil Field Products with Headquarters in Pittsburgh.

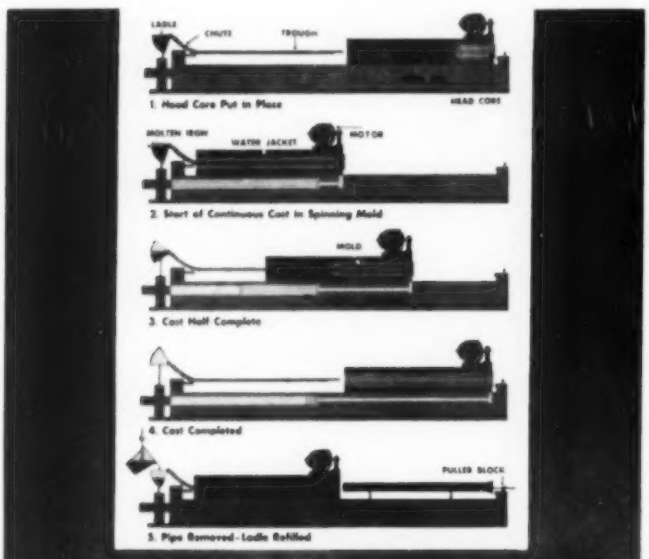
New Packing for Sealed Sewer Pipe Joints

503

Presstite Engineering Co., St. Louis, Missouri, has introduced "Ropax" sewer joint packing to be used in conjunction with bituminous joint sealing compounds.

According to the company, it is engineered to meet the need for tighter sewer joints where there are root troubles, adverse soil conditions, excessive ground water, and low infiltration requirements. The product has a processed fibrous core impregnated and saturated with a blend of selected asphalts.

When caulked, "Ropax" compresses and conforms in a compact mass to the shape of the bell, forcing the asphalt saturant into the pores and crevices of the pipe to effect a watertight seal. The saturant is designed to provide extra sealing material to the joint.



EVER SEE McWANE-PACIFIC Make CAST IRON PIPE?

McWane-Pacific operates probably the most modern and improved DeLavaud Centrifugal Cast Iron Pipe Foundries in the world at Birmingham and Provo, Utah. They incorporate many improvements over the original DeLavaud process. McWane-Pacific's centrifugal pipe casting machines are almost entirely automatic in operation—and each machine makes on the average one McWane-Pacific Q-check Cast Iron Pipe every 2 minutes.

The simplified diagram above illustrates the five steps through which a McWane-Pacific centrifugal machine goes in casting one pipe. When you have an opportunity, come and see these modern pipe foundries in operation.

McWANE Cast Iron Pipe Company
Birmingham, Ala.
Pipe Sizes 2" thru 12"

Sales Offices

Birmingham 2, Ala.	P. O. Box 2601
Chicago 1, Ill.	333 North Michigan Ave.
New York 6, N. Y.	80 Broad Street
Kansas City 6, Mo.	1006 Grand Avenue
Dallas 1, Texas	1501 Mercantile Bk. Bldg.

PACIFIC STATES Cast Iron Pipe Co.
Provo, Utah
Pipe Sizes 2" thru 24"

Sales Offices

Provo, Utah	P. O. Box 18
Denver 2, Colo.	1921 Blake Street
Los Angeles 48, Cal.	6399 Wilshire Blvd.
San Francisco 4, Cal.	235 Montgomery St.
Portland 4, Oreg.	501 Portland Trust Bldg.
Salt Lake City	Waterworks Equip't Co.

Rubber Tired Parsons Trenchliner

504

Parsons Company, Newton, Iowa, has announced a new highly mobile, rubber tired, ladder type Trenchliner that will handle all types of utility excavations. This Model 88 Trenchmobile digs to a maximum depth of 5 feet and widths of 8 or 12 inches.

Compact and highly maneuverable, the Model 88 has unlimited applications for digging trenches for mains and services and many other excavations within its range of widths and depths. Powered by a 43.6 h.p. gasoline engine, the Trenchmobile is a heavy-duty unit constructed for operating the bucket line, conveyor belt, travel and digging traction. Highly mobile, the 88 has road speeds up to 12.65 mph for self powered moves between jobs. Pneumatic tire mounting plus low ground pressure permits working and traveling over sidewalks, driveways and lawns without surface damage.

Permutit Appoints Bruns

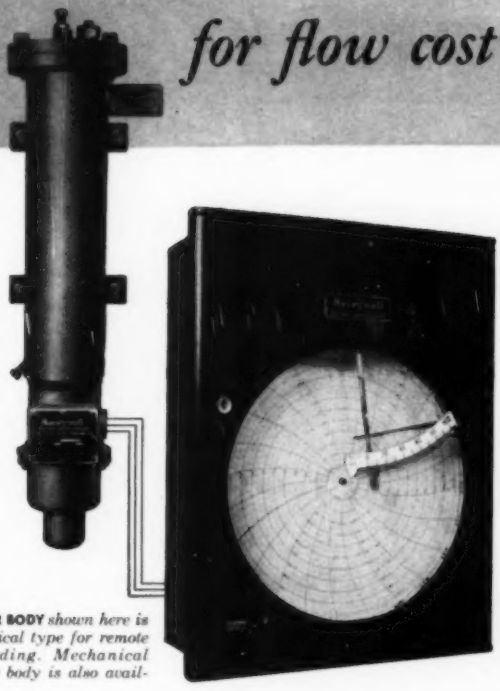
Permutit Company, Industrial Sales Dept., New York, N.Y., has announced the appointment of Mr. R. B. Bruns as District Engineer of its Philadelphia, Pa., office.

Mr. Bruns will assume the duties previously handled by Mr. D. J. Hess

(Continued on page 92A)

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

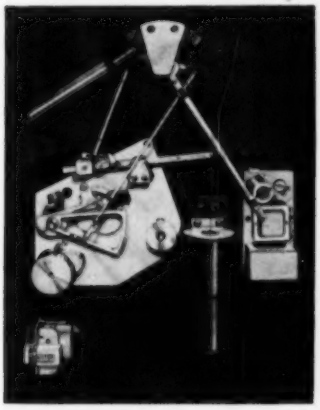
New evenly graduated flow meter *for flow cost accounting*



METER BODY *shown here is electrical type for remote recording. Mechanical meter body is also available.*

FLOW METER *with evenly divided chart is uniformly accurate . . . easy to read at all rates of flow.*

ELECTRONIC INTEGRATOR *is fast, accurate . . . eliminates slow, complicated totalizing . . . simple to service.*



AN IMPORTANT development in flow metering —the Brown Evenly Graduated Flow Meter— brings new accuracy and convenience to cost accounting of steam, oil, gas, water and other process fluids.

The instrument scale permits easy reading at full accuracy over its entire range. Electronic integration affords unmatched speed and accuracy in totalizing flow.

The electronic integrator, consisting of but three major parts, simplifies accessibility and maintenance . . . permits quick checking and calibration. Scanning is rapid and extremely simple.

The corrosion-resistant meter body is of tubular construction, reducing weight and bulk. The characterized bell is corrosion-resistant, too, and is specially designed to eliminate tilting.

This new flow meter is available either as a *mechanical meter* with integral body and recorder, or as an *electrical meter* for remote transmission to a centrally located recorder.

Call in your local Honeywell engineering representative for a discussion of your flow applications . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4575 Wayne Ave., Philadelphia 44, Penna.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

● *Important Reference Data*

Write for new Catalog No. 2300, "Flow Cost Accounting."

(Continued from page 90A)

who is retiring from active service in the company. Hess will, however, continue his relations with Permutit in an advisory capacity until June 30, 1952.

New pH Meter Features Compactness, Portability

505

Beckman Instruments, Inc., South Pasadena, Calif., has developed a new battery-operated pH instrument incorporating a number of revolutionary advancements that insure greater convenience and all-around adaptability in plant and field applications.

The complete instrument measures only 4 x 6 x 9½ inches overall, including built-in power supply, and weighs less than 8 lbs. The electrode support is mounted on the side of the case so that it can be easily rotated to permit the instrument to be used in either a horizontal or vertical position. The electrode plugs in directly to the side of the instrument case, permitting quick interchangeability of electrodes. The electrodes are said to be practically unbreakable, cover a pH range from 0 to 14, and can be safely used at temperatures ranging from freezing to boiling.

Link-Belt Elects Becherer President

Link-Belt Company, Chicago, Ill., at its Annual Meeting increased the number of directors from 12 to 14. The two new directors are Robert C. Becherer, recently elected president of the company, and William J. Kelly, president of Machinery & Allied Products Institute.

At the Directors' Meeting that followed, Robert C. Becherer was elected president to succeed George P. Torrence, who is retiring from active service in accordance with the company's retirement plan. All other officers were reelected.

Mr. Becherer joined Link-Belt in 1923, upon graduation from Purdue University, and was appointed General Manager of the company's Ewart Plant in Indianapolis in 1947. He was elected Vice President in 1951 and later in the year was appointed Executive Vice President, with headquarters in Chicago.

Be-Ge "Hydraspeed" Trencher

506

Be-Ge Manufacturing Co., Gilroy, Calif., has announced the new fast, maneuverable, and completely hydraulic Be-Ge "Hydraspeed" trencher that is said to dig up to 12 feet of trench per minute.

Mounted on a Case Model VAI industrial tractor, the "Hydraspeed" is easily moved from job to job under its own power and digs trenches up to 24 inches wide and 5 feet deep.

Digging speed and digging depth of the trencher are instantly controlled

You're burying your money's worth . . .

when you specify

WARREN

CAST IRON PIPE

"Built To Be Forgotten"

You can be **sure** you get 100 cents to the dollar when you plan your piping system around **WARREN** Cast Iron Pipe and **WARREN** Cast Iron Fittings.

WARREN Cast Iron Pipe is produced in all sizes from 2" to 84" with all types of joints . . . fittings in numerous non-standard patterns to meet unusual requirements.

Warren FOUNDRY & PIPE CORP.

55 LIBERTY STREET, NEW YORK 5, N. Y.

Bell & Spigot Pipe • Flange Pipe • Mechanical Joint Pipe

Flexible Joint Pipe • Short Body Bell & Spigot Specials

WARREN PIPE CO. OF MASS. INC. 75 FEDERAL ST. BOSTON, MASS.

STRENGTH...TOUGHNESS

RESILIENCY...MEAN

MAXIMUM LIFE!

95 Years of Continuous Service

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

hydraulically by levers at the operator's finger-tips. Back-filler blade is raised and lowered hydraulically. The "Hydratrans," is a fluid motor which regulates the digging speed of the trencher through direct chain drive to the rear tractor wheels.

Conveyor belt is reversible. Dirt can be thrown to either left or right of the trencher at the operator's option. Entire conveyor assembly can be shifted easily from right to left.

Jones New Manager Worthington Water Treating Division

Worthington Corp., Harrison, N.J., has announced the appointment of Mr. A. L. Jones as manager of the Water Treating Division.

Formerly manager of the sale of water treating and deaerator section of the Steam Power Division, Mr. Jones will now be in charge of sales, engineering, production and service of water treating equipment.

Mr. Jones, a graduate of Virginia Polytechnic Institute, started his career with Worthington as a student engineer in the company's Holyoke, Mass. plant. After serving a year he was appointed a sales engineer in the Kansas City territory. In 1933 he became assistant manager of the Steam Power Division. In 1945 he was appointed manager of the deaerator and water treating section of the Steam Power Division.

Two New Ion Exchange Resins by Permutit

507

Permutit Company, New York, N.Y., has announced two new resins, Permutit S-1 and S-2.

These resins are highly basic anion exchangers which are capable of removing silica from water in the ion exchange demineralization process. This removal of silica is very complete—down to a fraction of 1 ppm.

Permutit S-1 is especially resistant to reduction in basicity and capacity for silica removal when operated for a long period of time on many waters. Permutit S-2 has a higher capacity and greater regeneration efficiency

NEW

KENNEDY booklet to help you specify A.W.W.A. valves

The new KENNEDY BULLETIN 106 gives you the *complete* story on KENNEDY A.W.W.A. Gate Valves. It gives detailed specifications . . . lists the wide range of types, sizes, controls, accessories, and connections and gearing arrangements available. It's packed with important facts you need to know when ordering or specifying A.W.W.A. valves. It provides valuable reference material for your permanent file.

WRITE TODAY FOR YOUR COPY OF BULLETIN 106!

THE COMPLETE KENNEDY LINE also includes KENNEDY SAFETOP and STANDARD Fire Hydrants. The KENNEDY SAFETOP is an easy-to-repair, two-piece breakable hydrant for use where heavy traffic causes constant risk of collision damage. The KENNEDY STANDARD is a sturdy one-piece hydrant designed for dependable service in less hazardous traffic locations. Both are non-flooding compression type.

WRITE FOR BULLETINS 61 AND 105.

THE KENNEDY VALVE MFG. CO. • ELMIRA, N.Y.

Est. 1877

VALVES • PIPE FITTINGS • FIRE HYDRANTS

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

than Permutit S-1 but is not quite as strong a base as S-1. Regeneration of these resins is accomplished with a solution of sodium hydroxide which removes the silica from the exchanger and restores its activity.

Photoelectric Colorimeter and Turbidimeter

508

Hellige, Inc., Long Island City, N.Y., has announced a new "Chromatron" Photoelectric Colorimeter and Turbidimeter.

The instrument features selective color filters covering the entire visible spectrum, square and round absorption tubes, hermetically sealed photocell, extra large meter, and automatically focused bulb. It permits analysis of water and sewage in the most modern, scientific manner using A.P.H.A. and A.W.W.A. standard methods or any other colorimetric procedure.

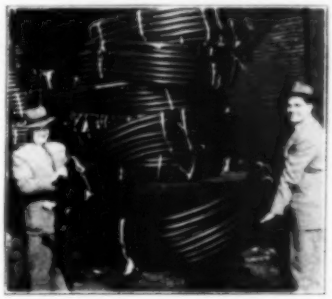
The colorimeter meets the highest requirements of laboratory accuracy, yet is exceptionally rugged to withstand rough handling in field or treatment plant.

Self-Priming Centrifugal Pumps

509

Rice Pump & Machine Co., Grafton, Wis., has announced the addition of three larger sized pumps, namely the 20M, 30M, and 40M, to their line of self-priming Centrifugal Pumps.

These pumps are powered with well-known makes of air-cooled gasoline engines. The design of these larger units include cartridge type shaft seals, open type non-clogging impellers, hardened steel wearing plates, built in check valves, and straight line flow of water through the suction openings to the impeller. These new sizes are available mounted on skids, on two pneumatic tired wheels or on steel wheels. The 30M and 40M on two pneumatic tired wheels are provided with trailer hitches as standard equipment.



Corrosion Proof Plastic Pipe

510

Plastex Pipe and Extrusion Co., Columbus, Ohio, has announced the manufacture of a complete range of flexible and rigid plastic pipe for every piping need.

The new product known as Plastex Corrosion Proof Pipe has positive resistance against rust, rot and electrolytic corrosion and the smooth interior surface provides maximum transmission. It is extremely light weight,

THE SILENT WATCHMAN

DIXIE TANK AND BRIDGE CO.

3523 LAMAR AVE. P. O. BOX 14
MEMPHIS 1, TENNESSEE

Complete Service for Elevated Water Tanks— Nation Wide Service—33 Years Experience

KEEP THE SAFETY FACTOR IN YOUR TANK THE DIXIE WAY

By welding seams, pits and rivets which gives a riveted tank 15% more Safety Factor than it had when built. No rivets removed, water supply maintained while work is in progress. On completely reconditioned jobs, the painting is guaranteed for three years, repairs guaranteed for ten years, provided the tank is painted every three years by Dixie Tank and Bridge Company, making all adjustments, if any, without additional cost.

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SOUND PRINCIPLES OF WATER TANK MAINTENANCE and TANK TALK, by W. A. RILEY

Dixie's Nation Wide Service Satisfies

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THE LARGEST ORGANIZATION OF ITS KIND GIVING SAFE MAINTENANCE AT LOW COST

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weighing about 1/10 that of equivalent metal pipe, and installations above or below ground are quickly accomplished without special tools and connections are easily made with cemented plastic fittings. Plastex Pipe comes in a complete range of standard pipe sizes from ½ up to 6 inches and coils are made up to 400 ft. long. Straight lengths, 25 ft. long, are also available.

Permutit Appoints Gilwood Director of Research

The Permutit Co., New York, N.Y., has announced the appointment of Martin E. Gilwood as Director of Research.

Mr. Gilwood, a graduate Chemical Engineer from Rensselaer Polytechnic Institute, Troy, N.Y., has risen in successive steps from the positions of Research Engineer to Assistant Manager of Research to Manager of Chemical Research and now to Director of Research.

He will be responsible for all operations of Permutit's research, analytical and pilot plant laboratories at Birmingham, N.J., and for market research activities from his office in New York.

Fast-Setting Floor Patch Material

511

Dasco Company, Inc., Baltimore, Md., has developed a new fast-setting floor patch material called "Redi-Patch."

This new plastic filler, which contains both metallics and pure rubber latex, is said to have a strength ap-

for valving corrosive and "hard-to-handle" fluids . . .

HILLS-McCANNA

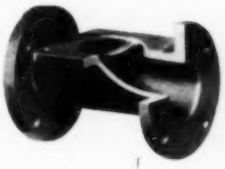
offers over 20,000 different "custom-made" assemblies on a standardized basis

32 standard operators

Methods of operation for Hills-McCanna Valves include hand-wheel and lever operators, sliding stem, air and hydraulic cylinders, diaphragm motors and electric motors in a variety of types.

14 standard diaphragms

Diaphragms, the heart of Hills-McCanna Valves, are offered in the widest choice to best suit your individual needs; 5 types of rubber, 3 of Neoprene plus Hycar, butyl, Tygon, Compar, special polyethylene and Kel-F.



48 standard body materials

Bodies for Hills-McCanna valves are furnished in cast iron, with or without such linings as rubber, glass, lead, etc.; in any machinable alloy or in such materials as Karbate, stoneware, porcelain, etc.

By offering such a broad selection of operators, diaphragms and bodies, Hills-McCanna is able to furnish so many standard combinations that the user is in the position of being able, in most cases, to find the exact valve that best fits his individual requirements. There is virtually never any need to adapt to your service a valve developed for someone else's needs.

The 36 page catalog No. V-52 gives full details on all Hills-McCanna Valves. Write for your copy. HILLS-McCANNA CO., 2357 W. Nelson St., Chicago 18, Illinois.

HILLS-McCANNA

saunders patent diaphragm valves

Also Manufacturers of Proportioning Pumps Force Feed Lubricators • Magnesium Alloy Castings

proximately 250% greater than ordinary floor-patch materials.

"Redi-Patch" can be applied to damp or dry concrete, asphalt, brick or mastic floor by one person. The hole is simply swept clean and the primer brushed into depth and sides. After this has set a few moments, "Redi-Patch" is taken from the drum and tamped level. No plasticizer is required. Within five to ten minutes after tamping, truckloads up to twenty tons may be driven over the patched areas without fear of powdering, rolling out or releasing itself in any way. "Redi-Patch" contains no stone or similar aggregates, or asphalt and is grease and oil resistant.

Roots-Connersville Blower Absorbed into Dresser Industries

Roots-Connersville Blower Corporation, Connersville, Ind., has been absorbed into the corporate structure of its parent, Dresser Industries, Inc., and is now operating under the name, "Roots-Connersville Blower," a Division of Dresser Industries, Inc.

Roots-Connersville will continue to operate as a separate, completely integrated organization at the same address, with identical plant and management as heretofore. Robert H. Owens having been appointed as President of this division, and Ralph Newquist, Executive Vice President.

Carlon Announces New Plastic Pipe

512

Carlon Products Corporation, Cleveland, Ohio, has announced the production of the new type "WS" plastic pipe which has been developed primarily for water service installations and applications involving high vacuum. Similar to the well-known "EF" flexible pipe, this new type has increased wall thickness for protection against burst or collapse when handling higher working pressures or to withstand water-hammer. The new pipe is also able to operate under partial vacuum or as a suction line.

Type "WS" pipe features flexibility, light weight and absolute resistance to rot, rust and electrolytic corrosion. Its smooth internal surface will not accumulate scale or sediment. The pipe is available in nine sizes ranging from ¾ to 6 inches nominal pipe size. Working pressure is 120 psi at 120°F. in the sizes up to 1½ inches and slightly less in the larger sizes.

Proportioneers Holds Annual Election

Proportioneers, Inc., Providence, R.I., at a recent annual meeting of stockholders, has announced that the following were elected to the Board of Directors for the ensuing year, for a period of one year:

Rudy P. Lowe, Henry S. Chafee, Earl H. Bradley, Robert H. Glan-

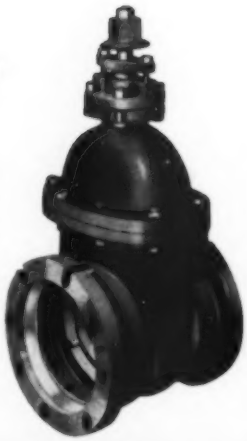
MECHANICAL JOINT

MH VALVE

FLEXIBLE BOLTED CONNECTION

M & H Mechanical Joint ends on gate valves are identical with mechanical joint standards adopted by the Cast Iron Pipe Research Association. It uses the stuffing box principle, by which a thick gasket is compressed into a stuffing box by a bolted gland or follower ring. It is a flexible, bottle tight joint, easy to make, and economical. Mechanical joint making in the field does not require a skilled workman. Mechanical joint permits deflection in any direction, also longitudinal expansion and contraction.

For complete information, write or wire M & H Valve and Fittings Company, Anniston, Alabama.



M&H PRODUCTS FOR WATER WORKS • FILTER PLANTS INDUSTRY • SEWAGE DISPOSAL AND FIRE PROTECTION

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

ville, Edward F. Pickering and Charles G. Haire.

The following were elected Officers of the Company for one year: Rudy P. Lowe, Pres., Earl H. Bradley, V.P. & Sec., Robert H. Glanville, V.P., Henry S. Chafee, Treas., B. C. Greenough, Asst. Treas. & Asst. Sec., L. M. Bullock, Asst. Treas., Charles G. Haire, Asst. Sec.

Submersible, Floatless Sump and Drainage Pump

513

Lancaster Pump and Manufacturing Co., Lancaster, Pa., has developed a new submersible Lancaster Drain-Pak.

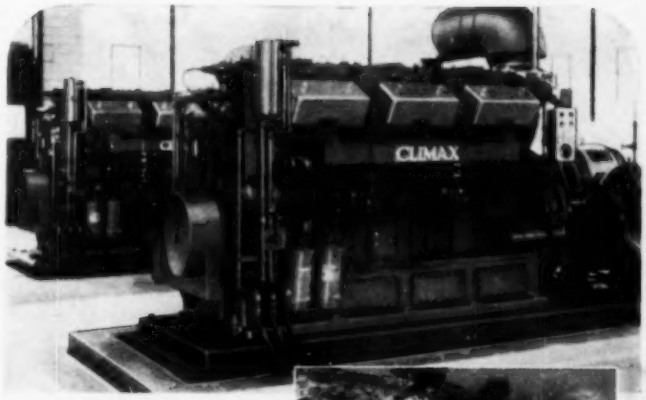
The new Drain-Pak is a small ⅓ h.p. all bronze sump and all-purpose pump with a stainless steel motor housing. One of the advantages claimed for the pump is its floatless construction. It has no float, diaphragm or electrodes.

Weighing only 31 pounds, the Lancaster Drain-Pak can be lowered to depths up to 15 feet. The maximum capacity is 3300 g.p.h.

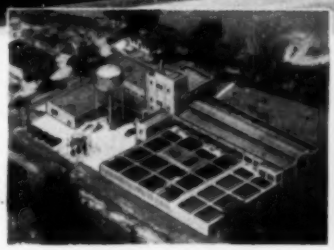
Area Flow Meters with Predictable Performance "Floats"

514

Fischer & Porter Company, Hatboro, Penna., has developed a Predictable metering float for the Flowrater "area" flow meter. Now, Flowrater instruments with true per-



Two Climax 420 H.P. 12 cylinder gasoline engines direct connected to 6 MGD centrifugal pumps in Municipal Water Works, Moline, Illinois.



Aerial View of Moline's New Pumping Station.

climax BLUE STREAK ENGINES

GUARD MOLINE'S WATER SUPPLY

Moline, a fast growing industrial city in Western Illinois, installed two Climax 12 cylinder and one 6 cylinder engines to guard their water supply. They are used as standby power for pump units during electrical power failures.

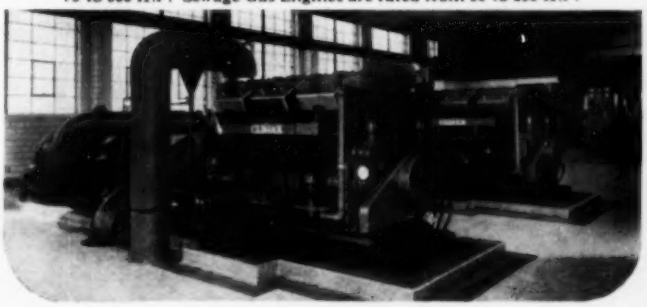
Selected because of their low upkeep expense, economy and their ability to provide quick dependable power to meet all emergency demands. Climax Engines have been approved and preferred by a growing number of municipal water works for standby service.

climax

ENGINE AND PUMP MFG. CO.

Factory and General Office: Clinton, Iowa
Regional Offices: Chicago, Ill., Dallas, Texas

For emergency use in water works Climax Engines are rated from 75 to 600 H.P. Sewage Gas Engines are rated from 50 to 250 H.P.



centage flow scales and factor tags can be stocked ready for immediate shipment.

According to the company, flow factors can now be changed with extreme simplicity to allow the application of any one meter to various services. Also, sight flow indicators, spare parts, metering tubes, etc., can now be supplied from stock.

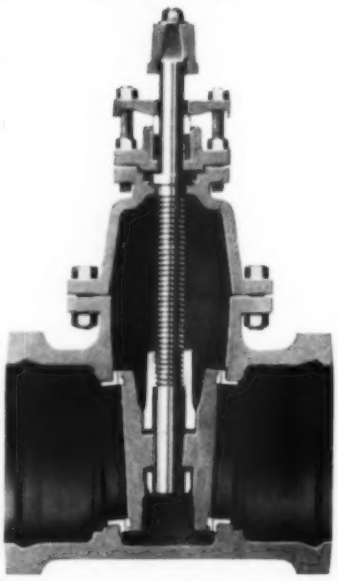
Pipe Line Service Corp. Expands Pipe Coating Facilities

Pipe Line Service Corp., Franklin Park, Ill., has announced the completion of a new Pipe coating and wrapping mill, designed specifically to handle pipe sizes up to 30 inches in diameter and 60 feet in length at the company's main plant.

The Franklin Park plant, with the completion of this new addition, now comprises two pipe coating mills and a modern machine shop on 21 acres, with ample available space for the storage and handling of customers' pipe. Three switch tracks serve the two mills, providing direct rail connections to the CMSTP&P railroad. A "Coating and Wrapping In-Transit" privilege permits pipe to be stopped off at the Franklin Park plant for processing and reshipment on through freight rates.

R.D.WOOD GATE VALVES COST LESS BECAUSE THEY LAST LONGER

Because they are buried deep underground, gate valves are always laborious and expensive to repair. In addition, interruptions to service are hazardous to health and safety. R. D. Wood Gate Valves are specially designed for long use. They are simple and rugged in construction. They are fully bronze mounted. With the ordinary precaution of one annual operation, they give generations of dependable service. Therefore, *R. D. Wood Gate Valves cost less because they last longer.*

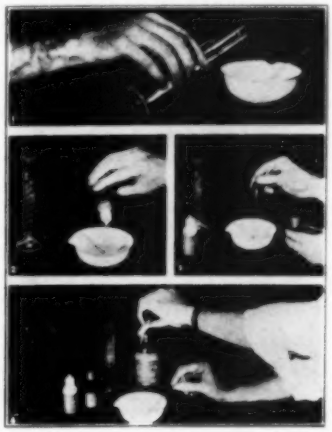


Only three moving parts the spreader and two discs. In opening, the discs are lifted into the bonnet entirely clear of the seats. In closing, they are wedged into place without distortion. Seasoned castings. Rigidly inspected. Working pressure up to 175 lbs. Tested to 300 lbs. Conform to AWWA specifications. Supplied with bell, flanged or mechanical joint pipe connections.

R.D.WOOD COMPANY

Public Ledger Bldg., Independence Square, Philadelphia 5, Pa.

Manufacturers of Mathews Hydrants and "Sand-Spun" Pipe (centrifugally cast in sand molds)



New Water Hardness Test Patents

515

Hagan Corporation, Pittsburgh, Pa., has confirmed that Dr. Gerold Schwarzenbach, noted Swiss scientist, has been granted U. S. patents Nos. 2583890 and 2583891, which cover the new water-hardness tests that have gained widespread use in the past two years in this country. The Hagan Corporation and its affiliated companies, are licensed under these patents.

Dr. Schwarzenbach, professor of chemistry at the University of Zurich and associated with the Swiss firm, Chemische Fabrick Uetikon in this development, is credited with revolutionizing the test procedures for water hardness. His method for total hardness determination has proved rapid, simple, and accurate within 1 part per million, compared with the century-old "soap-shaking" method which is slow, cumbersome and involves considerable subjective judgement.

A spokesman for Hagan Corp. stated that its affiliate, Hall Laboratories, Inc., had worked out modified procedures, reagents and equipment which make the basic Schwarzenbach methods convenient for field use.

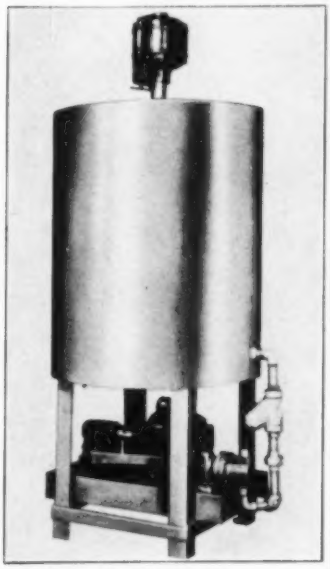
Both total hardness, and hardness due to calcium alone, can be quickly and precisely determined by the new test methods. Magnesium can be determined by difference. The method for total hardness is especially sensitive to small amounts; with no special precautions 1 ppm of hardness as $CaCo_3$ is detected, and with special techniques and more dilute titrating solutions even lower concentrations can be determined.

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

The endpoint of a test for total hardness is sharp and readily detected so that the "human factor" is practically eliminated in the new test.

There is no limitation on sample size, other than economy of operation, since no scum or salt effect can obscure the endpoint. Further, the new methods are widely applicable to high or low hardness, even in fairly concentrated brines.

The accompanying picture illustrates the simple and fast procedure in making the test, step-by-step; (1) measured sample poured into porcelain dish; (2) Add buffer solution and mix well; (3) Add indicator and stir well, the sample is now red; (4) Titrate to endpoint represented by change from red to purplish blue.



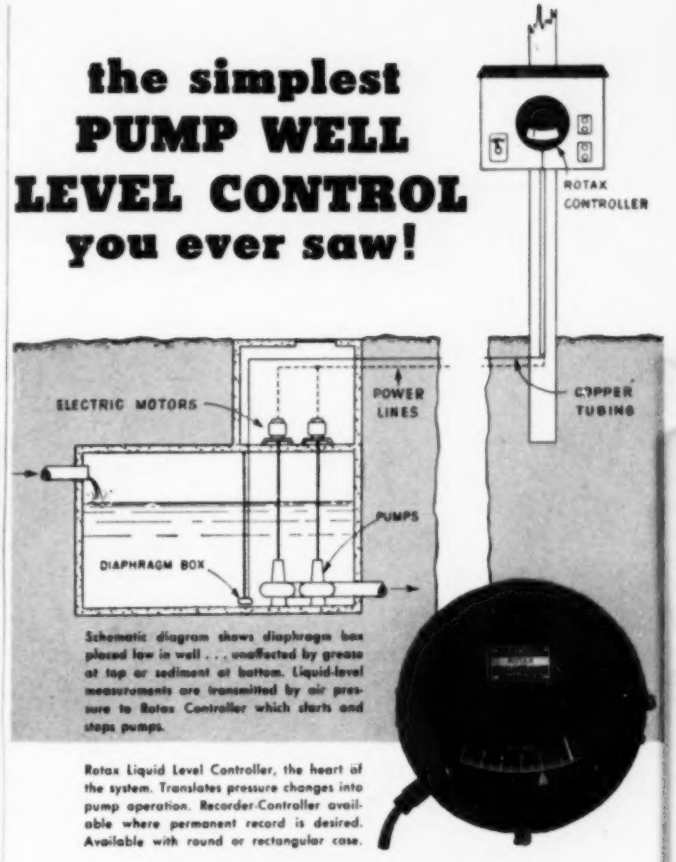
"Packaged" Chemical Feed Unit

516

Bird-Archer Company, Philadelphia, Pa., has announced a new chemical feed packaged unit, which delivers liquids in desired amounts under pressure.

According to the manufacturer, this self-contained, extra heavy Baco unit offers high pressure controlled feed at low cost. The chemical reservoir tank is of sturdy welded steel construction available in 50 or 100 gallon capacity. The chemical proportioning pump can be designed for various rates of feed at different pressures. A specially designed motor-driven agitator assures completely mixed fluids at all times. A stainless steel strainer is provided between the suction side of

the simplest PUMP WELL LEVEL CONTROL you ever saw!



Schematic diagram shows diaphragm box placed low in well . . . unaffected by grease at top or sediment at bottom. Liquid-level measurements are transmitted by air pressure to Rotax Controller which starts and stops pumps.

Rotax Liquid Level Controller, the heart of the system. Translates pressure changes into pump operation. Recorder-Controller available where permanent record is desired. Available with round or rectangular case.

Easier to install . . . accurate for years without attention

For a new underground sewage pumping station, the town of Norwood, Mass., wanted automatic control that would perform dependably without attention, free from usual corrosion and maintenance problems. Foxboro Pump Well Level Control proved an effective solution . . . with the added advantages of greatly simplified installation and operation.

Foxboro Pump Well Level Control employs a simple cast iron or bronze diaphragm pressure box for measurement . . . instead of a float-type measuring system. No cables, levers, floats or pulleys to corrode or clog. The Foxboro Controller may be located up to 500 ft. from the well, with only a copper or stainless steel tube connection. All adjustments easily made at the instrument. Controller contacts not subject to corrosive atmosphere.

Get full details of this improved automatic Level Control for either water or sewage pump wells. Write for Application Engineering Data Sheet 831-9. **The Foxboro Company, 2285 Neponset Ave., Foxboro, Mass.**

FOXBORO Reg. U.S. Pat. Off. PUMP WELL LEVEL CONTROL

the pump and the tank. The pump is mounted below the tank to minimize air binding and to maintain a positive suction head.

A duplex-pump model with divided tank is also available. Both types of units are supplied complete with all necessary piping and are ready for connection.

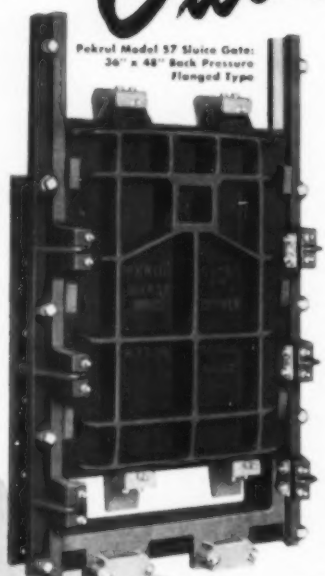
Worthington Simplifies Name

Stockholders of mouth filling Worthington Pump and Machinery Corporation at a recent meeting re-elected the present board of directors and voted to shorten the company's name to Worthington Corporation. For the most part the corporation will be referred to as simply WORTHINGTON.

In a statement announcing the change, Mr. H. C. Ramsey, President, said, "While we are proud of the fact that the name 'Worthington' has meant 'pumps' to the world at large for more than a century, we are equally proud of the fact that during this same period Worthington has extended its activities into many other fields with the result that today, with few exceptions, every industrial and commercial enterprise is a potential user of one or more of the many other items of our equipment. Because of our wide diversification we believed that the continued reference to 'pumps' in the corporate name tended to lead the public into the erroneous conclusion that pump manufacture was our only endeavor. Such, of course, is not the case."

President Ramsey also stated that no policies or practices of the company will be affected in any way by the name change.

Pekrul Gates



Pekrul Model 57 Sluice Gate: 36" x 48" Back Pressure Flanged Type

PEKRUL GATES are engineered to meet the most rigid requirements for:

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Irrigation
Water Works
Dams
Sewage Disposal
Reservoirs
Pumping Plants
Oil Refineries
Fish Hatcheries
Rearing Ponds
Recreation Pools
Cooling Towers
Steel Mills

PEKRUL GATE DIVISION

MORSE BROS. MACHINERY
DENVER, COLORADO

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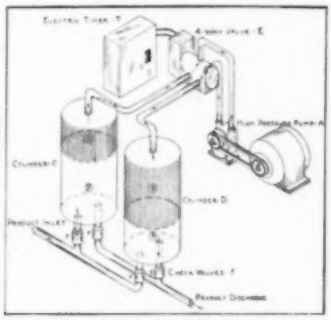

New Pump for Corrosive, or Abrasive Products

517

Manton-Gaulin Mfg. Co., Everett, Mass., has developed a new pump, called a Hydrex Pump, which readily transfers products that were formerly difficult or impossible to pump.

Pumping is accomplished by two fluid pistons; a high pressure pump that pumps hydraulic fluid alternately to and from the two pistons and a four way hydraulic valve that is actuated by a solenoid, to control the direction of the fluid. The cylinders are made of stainless-steel or other materials where required.

The Hydrex is designed to handle slurries, very viscous pastes, abrasive or corrosive fluids, and suspended solids without damage to the pump. Where contact between the pumping medium and the product must be avoided a suitable membrane is provided.

Simple and sanitary, there are no bearings, mechanical pistons, packing glands, valves or impellers in the cylinders.

New Hough Representative for Eastern District

The Frank G. Hough Co., Libertyville, Ill., has announced the appointment of Carl W. Tuohey as representative for Sales District No. 2, comprising the states of New York, New Jersey, Pennsylvania, Virginia, Delaware, West Virginia, and New England.

(Continued on page 101A)

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

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Enter key number in box.

Please PRINT your name and title, company or department name, and your address

NOTE—

These cards are to be used only for items described in THIS ISSUE

WATER & SEWAGE WORKS

Will see that you receive information desired.

(Continued from page 100A)

Mr. Tuohey joined the Hough organization in June, 1950, and has had intensive training for his new duties. He is an engineering graduate of Purdue University and was an Army Air Corps Lieutenant in World War II. He will fill the vacancy created when William Cornell was recalled to active service with the Marines.

Carbide Tipped Concrete Drill Bit

518

New England Carbide Tool Co., Cambridge, Mass., has designed a Thunder-Core carbide tipped drill bit for drilling holes ¾ to 5 inches in diameter in hard masonry.

The new bit enables one man to quickly and easily drill holes through materials such as concrete with bluestone or granite aggregate and even solid granite with no binding.

According to the company, the new Thunder-Core bit has been thoroughly tested in the field with excellent results, is now in production, and will soon be available nationally through selected dealers.

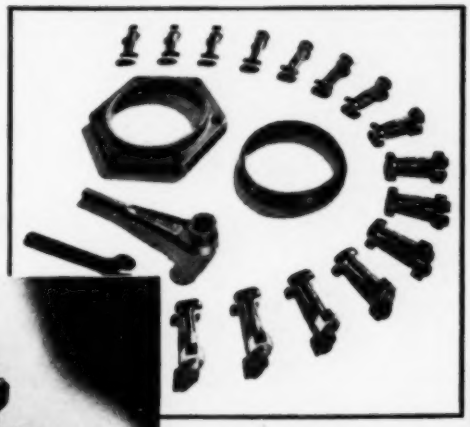
Ratio Totalizer

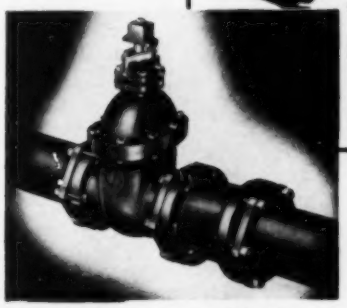
519

Hagan Corporation, Pittsburgh, Pa., has announced an improved design of the Hagan Ratio Totalizer.

The Hagan Ratio Totalizer is a pneumatically operated control mechanism, almost universally applicable for accurately combining input control addition, subtraction, multiplication, division or more complicated functions of the input control signals. The output signal represents any desired combination of the input signals. A maximum of three input signal pressures plus three spring pressures can

ALL YOU NEED





IS: A RATCHET AND OPEN END WRENCH, THREE RUBBER GASKETS, THREE CAST IRON FOLLOWER RINGS AND A HAND FULL OF BOLTS AND NUTS TO INSTALL

the New SMITH CUT IN VALVE & SLEEVE

Gone are the days of—large costly excavations—melting furnaces and pouring pots—pouring and caulking lead joints—when the New All Mechanical Joint Smith Cut In Valve and Sleeve is used.

The Cut In Valve can be installed rapidly, in fair or stormy weather on Cast Iron A.W.W.A. and Federal specification water mains, by unskilled labor, using only two wrenches.

Moulded rubber gaskets fit into machined "Stuffing Box" type joints, guaranteeing a permanent leak proof seal.

Smith Cut In Valves are manufactured in compliance with the A.W.W.A. Gate Valve specification, and all parts are interchangeable with like parts of Smith A.W.W.A. Gate Valves.

Write for Bulletin No. MJ2

37

THE A.P. SMITH MFG. CO.
EAST ORANGE, NEW JERSEY

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TENNESSEE CORPORATION

SODIUM FLUOSILICATE
(Silico Fluoride)

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Sewage and Garbage Shredders
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CRUSHER & PULVERIZER CO.
ST. LOUIS 6, MO.

be accommodated in a single unit. Accuracy of output signal is said to be within one per cent of full scale reading.

Oliver Filters Appoints Hoxie

Oliver United Filters, Inc., New York, N.Y., has announced the appointment of James B. Hoxie as Western Division Sales Manager, with headquarters in Oakland, California.

Mr. Hoxie, who has been with the company for 20 years, succeeds Philip J. McGuire who has been appointed Director of Research and Development. Mr. Hoxie is familiar with both sales and manufacturing, having spent about 10 years in the company's Central Sales Division territory, working out of Chicago, and 10 years in the factories.

Chemical Treatment Destroys Rust and Phosphatizes Metals

520

Octagon Process Inc., Staten Island, N. Y., has developed a new chemical treatment that removes rust, tarnish, light oil, and chemically prepares metals for paint.

Known as "Rustclean," the new compound destroys rust and rust-promoting surface contaminants, thereby retarding corrosion. "Rustclean" not only chemically cleans the surface of steel, iron, aluminum, zinc and cadmium, it also forms a phosphate coating which acts as a base for organic finishes.

According to the company, "Rustclean" is safe to use. It contains a mild acid, which offers very little hazard to personnel. It hasn't the corrosive action of strong pickling compounds and doesn't fume, or emit toxic vapors.

ORDINARY
Chlorine
Gas
Feeder
Vital control parts subjected to corrosive, moist chlorine gas.
Chlorine hydrate impairs operation.
Gives off objectionable, corrosive fumes.
Difficult to change from manual to automatic operation.
Non-linear flow meter; limited range.
Stuffing boxes in chlorine flow system.
BUILDERS
Chlorinizer
Meters and controls chlorine gas in the dry non-corrosive state.
No chlorine hydrate in vital control parts.
No odorous, corrosive fumes.
Easily adapted for change in feeding load or mode of operation.
Positive, linear flow meter for equal ease and accuracy of reading throughout wide range.
No stuffing boxes or packed valves in chlorine gas system.

WHICH CHLORINE GAS FEEDER WOULD **YOU** BUY ?

Some chlorinating equipment invites trouble . . . other equipment avoids it! When you buy or specify chlorine gas feeders, remember this fact: BUILDERS Visible Flow CHLORINIZERS have been designed and constructed with one aim in mind — to give you the best chlorinating service with the least amount of trouble. May we show you why these chlorine gas feeders set a new standard in efficient, dependable service?

For Bulletins describing Builders Chlorinizers, address Builders-Providence, Inc. (Division of Builders Iron Foundry), 350 Harris Ave., Providence 1, Rhode Island.

BUILDERS PROVIDENCE Instruments

Worthington Names C. K. Hood Vice President

Other Managers Promoted

Worthington Corporation, Harrison, N.J., has announced that C. K. Hood, formerly manager of the corporation's New York District Sales Office, has been elected a Vice President.

Mr. Hood will be responsible for the direction of the activities of the Public Works, Steam Power, Deaerating, Water Treating, and Steam Turbine Divisions and will report to T. Cruthers, Vice President. A graduate of Iowa State College, Mr. Hood started his career with Worthington in 1918 and has been manager of the New York District Sales Office since 1930.

W. J. Van Vleck, present manager of the corporation's Atlanta District Sales Office, will succeed Mr. Hood as manager of the New York Office. C. W. Kramer, resident general line salesman in Birmingham, Ala., will succeed Mr. Van Vleck as manager of the Atlanta office. I. W. Leggett, general line salesman at Charlotte, N.C., has been appointed manager of the Charlotte Branch Office.

Condensifilter

521

Hankison Corporation, Pittsburgh, Pa., has available the Hankison Model B-30 Condensifilter. The Condensifilter is a device which dehydrates and

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

cleans compressed air used for operating instruments.

Measuring only 15 inches high by 9 inches in diameter, it combines in a single compact unit—a mechanical filter, a dehydrator and automatic trap. When connected to a compressed air line, it removes entrained and vaporized water and oil, oil sludge, scale and other foreign materials from the air. Rated capacity is 30cfm at 100 psi; but when greater capacity or uninterrupted service is required, several units can be installed in parallel.

Burette Filled by Squeezing Reservoir

522

Hagan Corporation, Pittsburgh, Pa., has announced a new burette unit featuring a plastic (polyethylene) reservoir base which requires only a squeeze to fill an automatic self-leveling burette.

The "Squeez-O-Matic" is said to be easy and simple to use, a time-saver, and requires only one hand, whereas older automatic burette assemblies required use of both hands—one for closing a tube orifice, the other for squeezing an aspirator bulb.

Use of a plastic reservoir, a specially machined polyethylene bottle, not only makes the operation of the burette unit easier and simpler, but also provides a container which is highly resistant to chemical attack and will not contaminate standard titrating solutions.

Another feature of the unit is the special base which holds the plastic

FILER & STOWELL SLUICE GATES

are built to stand long trouble free service. Amply proportioned for all stresses of shipment, erection and operation. They may be obtained with manual, hydraulic cylinder or motor operating controls.

THE FILER & STOWELL COMPANY
MILWAUKEE 7, WISC.

STOP

JOINT

LEAKAGE

USE

CARSON CLAMPS

With Pearlitic C.I. Bolts for Cast Iron Pipe and Fittings.

Write for Prices.

H. Y. CARSON

1221 PINSON ST. BIRMINGHAM, ALA.

Servicing Water Holders All Types Elevated and Standpipes. Specially designed materials that hold down corrosion.

IT'S THE APPLICATION THAT COUNTS

All guaranteed work.

SPEELMON ELEVATED TANK SERVICE

Complete Painting & Repair Service

822 N. Court St. Rockford, Ill.

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

bottle and also provides a convenient and stable platform for beaker, flask or dish.

Sterling Electric Motors Appoints Additional Distributors

Sterling Electric Motors, Inc., Los Angeles, Calif., has announced the appointment of the following distributors:

Industrial Electrical Co., 1244 McHenry Ave., Box 1025, Modesto, Calif.

Butte Machinery Co., 510 E. Aluminum, Butte, Montana.

Pomona Electrical Machinery Co., Inc., 260 N.E. End Ave., Pomona, Calif.

Industrial Motor Electric, 449 West Street, Woodland, Calif.

Meyer Brothers Company, Phillipsburg, Pa.

Transmission Equipment Co., 527 Lexington Ave., New York 17, N.Y.

Basket for Pipette Washers

523

Fisher Scientific Company, Pittsburgh, Pa., has developed a new basket for the Fisher Pipette Washer that makes it impossible for pipettes to protrude beyond the sides of the holder to be chipped or broken while being washed.

The stainless-steel basket supports pipettes for storing, washing, rinsing and transferring, and replaces previous models.

The improved Fisher Pipette Washer, has a glass cleaning chamber with an integral automatic syphon. It is used for the flushing and rinsing steps; soaking and cleaning are done in a separate jar. The washer occupies only one square foot of space and can be set up in a corner of the sink. A hose is connected to the water tap and to a serrated hose connector at the base of the washer.

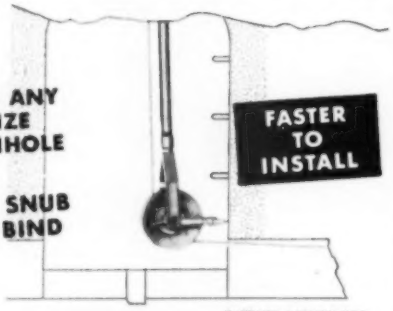
FLEXIBLE
"Surface-Hung"
MANHOLE
ROLLER

It's New! Revolutionary!

- Operates at any angle of circle without moving machine. Adjust platform only.
- Installs in a fraction of the time of ordinary jacks. No holes to chisel in bricks.
- Hangs in manholes too narrow for present jacks.
- No rebuilding of manholes necessary. Operates in "loose brick" manholes.
- Less snub on roller eliminates cable bind. Bucket passes easier.

FITS ANY SIZE MANHOLE

LESS SNUB NO BIND



PATENTS APPLIED FOR

"FLEXIBLE"
SEWER-ROD EQUIPMENT CO.
9033 VENICE BOULEVARD, LOS ANGELES 34, CALIF.

WRITE today

41 Greenway St. — Hamden 14, Conn.
147 Hillside Terrace — Irvington, N. J.
P.O. Box 465 — Memphis, Tennessee
1115 Delaware Ave. — Fort Pierce, Fla.
141 W. Jackson Blvd. — Chicago, Ill.
200 Magee Bldg. — Pittsburgh, Penn.
66 Kinlry Drive — Rochester 9, New York
29 Cordan Avenue — Roslindale 31, Mass.
801 E. Excelsior Blvd. — Hopkins, Minn.
3786 Durango St. — Los Angeles 34, Calif.
4455 S.E. 24th Street — Portland, Oregon
Francis Hankin — Montreal & Toronto, Can.
351 West Jefferson Blvd. — Dallas, Texas

AMERICA'S LARGEST MANUFACTURER OF PIPE CLEANING TOOLS AND EQUIPMENT

Ditcher Works With Farm Tractor

524

Vermeer Mfg. Co., Pella, Iowa, has just placed on the market the Vermeer "Pow-R-Ditcher," which will work with any farm tractor.

The "Pow-R-Ditcher" will dig a 10 to 14 inch ditch, 6 feet deep, at a rate up to 3 feet per minute, depending upon soil conditions. The ditcher is trailer mounted and uses direct drive from the tractor power take-off. It is a one man operation from the tractor seat and is simple to install by merely hooking onto the drawbar and power take-off.

The long wearing cutting blades are mounted on heavy roller chain and are easily removed for sharpening or replacement. All dirt is conveyed to one side of the ditch.

Newman on Military Leave from Wallace & Tiernan

Wallace & Tiernan Co., Inc., Newark, N.J., has announced that Warren J. Newman, District Engineer for the company, covering the northeast section of Pennsylvania for the last seven years, has been recalled back to duty with the U. S. Navy. Mr. Newman will be on a military leave of absence and is expected to return in a year and a half to two years.

Light-Weight Clay-Digger

525

Independent Pneumatic Tool Co., Aurora, Ill., has announced a new lightweight Thor pneumatic clay-digger featuring interchangeable parts to meet every clay digging requirement.

The new No. 16 Digger offers optional inside or outside trigger, closed retainer or latch retainer, choice of

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

five chucks for square, hexagon, or combination hexagon and round shank steels.

The manufacturers state that the interchangeable features were incorporated into the tool after three years of surveys and field tests.

The new Thor No. 16 weighs 20 lbs., is 19½ inches long and is equipped standard with chuck to take steels with ¾ inch square x 2¾ inch long shanks. Optional chucks take ¾ hexagon x 2¾ inch shanks; ⅞ hexagon by either 2¾ or 3¼ inch long shanks; and combination .882 hexagon and 1.027 round x 3¼ inch long shanks. Accessories available in these shank styles include clay spades or scoops, flat picks, saw tooth chisels, moil points, narrow chisels and chisel blanks.

Laboratory Dryer

526

Denver Equipment Co., Denver, Colo., has announced the development of a new laboratory dryer that incorporates the latest features of design and precise control of temperature and circulation.

The compact, inexpensive dryer operates on single phase, 50-60 cycle, 110 or 220 volts A-C. It has an asbestos air-cell insulated oven using a pair of standard, easily replaced heating elements. This insulation, combined with tight construction, keeps the heat in the dryer oven.

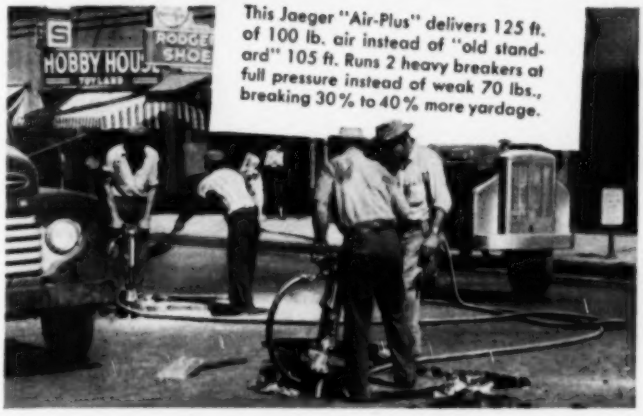
Exact temperature is maintained with a thermostat control that enables precise adjustments of temperature between 0 and 325°F. A sensitive stem thermometer is inserted into an opening in the top of the dryer to permit temperature readings without opening the doors.

Proper humidity and drying conditions are maintained with a forced-air circulating damper on the back of the dryer. It has 3 stages of adjustment.

Filtration Engineers Appoint Poole

Filtration Engineers, Inc., Newark, N.J., has announced the appointment of Arthur E. Poole as Sales

You Can Do 4 Days' Work in 3 with "New Standard" Jaeger Compressors



This Jaeger "Air-Plus" delivers 125 ft. of 100 lb. air instead of "old standard" 105 ft. Runs 2 heavy breakers at full pressure instead of weak 70 lbs., breaking 30% to 40% more yardage.

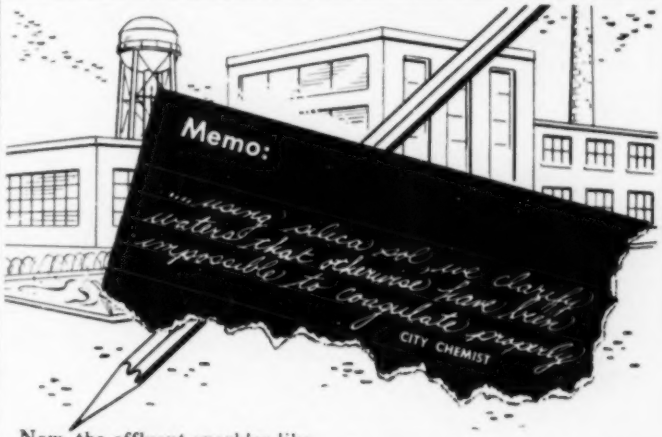
75 ft. 125 ft. 185 ft. 250 ft. 365 ft. 600 ft.

30% to 40% increases in production are yours with any "new standard" Jaeger from Model 75 that holds full pressure in a heavy pavement breaker up to Model 600 that runs 2 heavy wagon drills at full pressure with air to spare for hand-held drills. Jaeger Compressors deliver this 15% to 25% extra air at lowest cost per cubic foot of air of any compressor.

See your Jaeger distributor or write for Catalog JC-1.

THE JAEGER MACHINE COMPANY 480 Dublin Avenue Columbus 15, Ohio

PUMPS • MIXERS • HOISTS • TRUCK MIXERS • PAVING SPREADERS and FINISHERS



Now, the effluent sparkles like spring water with N-Sol activated silica. This coagulant aid increases size, strength and density of floc. All types of water (flood, well, surface waters, highly colored waters) are treated regularly by the N-Sol Processes.

N-Sol Activated Silica is easy to prepare in your plant by reacting N_a Silicate of Soda with ammonium sulphate, chlorine, alum or sodium bicarbonate. Send for bulletin #52-19.

PQ **N-Sol® Processes** PQ SOLUBLE SILICATES

PHILADELPHIA QUARTZ COMPANY, 1166 Public Ledger Building, Phila. 6, Pa.

The practical, economical answer to your underdrain problems

LEOPOLD

Glazed Tile

FILTER BOTTOMS

Successfully serving over 200 PLANTS with a daily capacity of over THREE-QUARTER BILLION GALLONS!

The Leopold Duplex Filter Bottom is made up of individual blocks, each weighing about 100 pounds, which are firmly joined together to provide a strong bed that is not disturbed by wash water. With this efficient, enduring system, you're assured an equal collection of filtered water with extremely low loss of head. There is no possible corrosion or tuberculation anywhere in the filter bottom.

Made of deaired fire clay—vitrified and salt glazed, the highly efficient Leopold Filter Bottom requires only shallow depth of small sized filter gravel and is acid and alkali resistant. Adaptable to any rectangular filter unit, it won't absorb any detrimental amount of water—and it's permanent.

Complete Water Purification and Sewage Plant Equipment . . .

- DRY CHEMICAL FEEDERS
- FILTER OPERATING TABLES
- MIXING EQUIPMENT

Write for details

F. B. Leopold Co., Inc.
2413 W. Carson Street
Pittsburgh 4, Pa.

Manager of the Filtration Fabrics Division.

Prior to accepting this appointment, Mr. Poole was General Sales Manager of the Chemical Equipment Division of General Ceramics Company, and also served as Manager of the Eastern Division of Werner G. Smith Division of Archer-Daniels-Midland Company. He is a graduate of Brooklyn Polytechnic Institute, with a degree in Chemical Engineering, and has studied Business Administration at Rutgers University.

Electric Stop Watch

527

Laboratory Industries, Inc., Chicago, Ill., has developed the Lab-Chron, an electric stop watch.

The unit contains a synchronous motor and timer that were designed to do a specific timing job—that of counting 1/10 seconds to 9999.9 seconds, or in the minute model 1/100 minutes to 999.99 minutes.

The specially designed counting unit, with built-in reset mechanism, and high torque synchronous motor was designed to function as a single unit, thus providing smooth effortless operation that will give trouble-free performance throughout the Lab-Chron's useful life.

Case is heavy cast aluminum, finished in metalized grey hammerloid which is baked on. Four rubber feet protect table top and prevents sliding.

Instrument Course Offered by F. & P.

Fischer & Porter Co., Hatboro, Pa., has announced that its next instrumentation course will be held at the Hatboro plant May 12, through 16, 1952.

This course will cover manufacture, calibration, installation, and operation and maintenance of primary and secondary process control instruments.

The DRIVE* that assures you *continuous sewage service

JOHNSON

Right Angle

GEAR DRIVE

for Sewage Applications

HEALTH PROTECTION . . . Dependable for continuous 24 hour constant service.

AVAILABLE . . . Manufactured in sizes, types and ratios to meet varied applications.

DEPENDABILITY . . . High efficiency and all-weather service. Low operating cost.

WORLD WIDE ACCEPTANCE . . . In recognition of dependable service, economy of operation and maintenance. Hundreds now in use by municipalities.

INVESTIGATE NOW . . . Get the facts on the Johnson Right Angle Gear Drive. Send for illustrated catalog.

PHOTO: Type 3 — automatic dry pit municipal sewage installation at Stratford, Connecticut—electric motor or engine drive.

JOHNSON GEAR
AND MANUFACTURING CO.
"45 years of Engineering Service"
8th & Parker Streets • Berkeley 10, Calif.

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

Users of the company's line of "Flow-rator" instruments will find the course particularly valuable.

Meetings Scheduled

(Continued from page 77A)

Oct. 14-17—Atlantic City, N.J. (*Chalfonte Hotel*)
PENNSYLVANIA WATERWORKS ASSOCIATION. Sec'y, W. A. Kufs, 510 Telegraph Bldg., Harrisburg, Pa.

Oct. 20-22—Pittsburgh, Pa. (*Wm. Penn Hotel*)
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec'y, William Porter, Wm. Penn Hotel, Pittsburgh 30, Pa.

Oct. 20-24—Cleveland, Ohio
AMERICAN PUBLIC HEALTH ASSOCIATION. Sec'y, Mrs. W. R. Walsh, A.P.H.A., 1790 Broadway, New York, N.Y.

Oct. 23-25—Atlantic City, N.J. (*Hotel Madison*)
NEW JERSEY SECTION A.W.W.A. Sec'y, C. B. Tygert, Box 178, Newark 1, N.J.

Oct. 23-25—Mason City, Iowa (*Hanford Hotel*)
IOWA SECTION A.W.W.A. Sec'y, H. V. Pedersen, Municipal Bldg., Marshalltown, Iowa.

Oct. 28-31—Pasadena, Calif. (*Huntington Hotel*)
CALIFORNIA SECTION A.W.W.A. Sec'y, John C. Luthin, 1113 Laurent St., Santa Cruz, Calif.

Oct. 29-31—Washington, D.C. (*Wardman Park Hotel*)
CHESAPEAKE SECTION A.W.W.A. Sec'y, Carl L. Lauter, 6955 33rd St., Washington, D.C.

Nov. 3-5—Montebello, Quebec (*Seigniory Club*)
CANADIAN INSTITUTE OF SEWAGE & SANITATION. (Annual Meeting) Sec'y, Dr. A. E. Berry, Parliament Bldgs., Toronto, Ont.

Nov. 5-7—Old Point Comfort, Va. (*Chamberlin Hotel*)
VIRGINIA SECTION A.W.W.A. Sec'y, W. H. Shewbridge, Regional Engr., 708 State Office Bldg., Richmond, Va.

Nov. 10-12—Hendersonville, N.C. (*Hotel Skyland*)
NORTH CAROLINA SECTION A.W.W.A. Sec'y, E. C. Hubbard, State Board of Health, Raleigh, N.C.

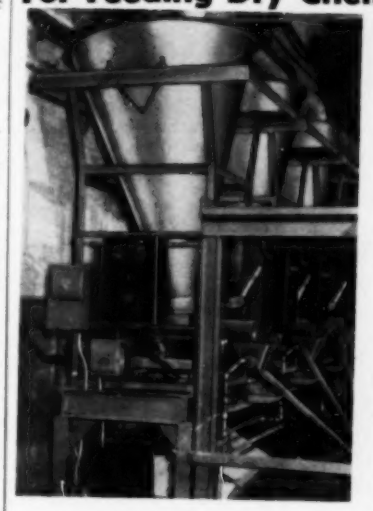
Nov. 16-19—Pensacola, Fla. (*Hotel San Carlos*)
ALABAMA-MISSISSIPPI SECTION A.W.W.A. Sec'y, C. W. White, State Board of Health, 519 Dexter Ave., Montgomery 4, Ala. (Joint Meeting). FLORIDA SECTION A.W.W.A. Sec'y, M. R. Boyce, 504 Pennsylvania Ave., Clearwater, Fla.

Dec. 4-6—Havana, Cuba
CUBAN SECTION A.W.W.A. Sec'y, L. H. Daniel, Baratillo 9, Havana, Cuba.

Dec. 7-10—Cleveland, Ohio (*Hotel Cleveland*)
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS. (Annual Meeting). Sec'y, F. J. Van Antwerpen, 120 East 41st St., New York 17, N.Y.

Dec. 10—Winthrop, Maine
MAINE WATER UTILITIES ASSOCIATION. Sec'y, Earle A. Tarr, Winthrop Water District, Winthrop, Me.

For Feeding Dry Chemical Reagents—



3 Open Model FM-1-80 Feeder Machines feeding in a water treatment system. (Also available in Cabinet style Models for different sized treatment systems.)

SYNTRON
"Vibra-Flow"

DRY FEEDER MACHINES

Each machine is a complete unit, having a supply hopper equipped with a Syntron electromagnetic Vibrator to assure a free flow of chemical to the Syntron "Vibra-Flow" Vibratory Feeder which in turn controls the flow of chemical into the system.

Minimum feed rates as low as 8 pounds per hour of most chemicals with standard control—lower feed rates per hour may be obtained with a special control.

Volume control of rate of chemical feed may be made by manually adjusting the rheostat in the machine's control panel—automatically by scale movement—or by impulses from pH and venturi devices.

Write Now for FREE Catalog Folder

SYNTRON COMPANY
650 Lexington Avenue — Homer City, Penna.

PRE-STRESSED "GUNITE" WATER TANK

We built the above pre-stressed "GUNITE" tank in 1944. It is 90' in diameter with a water depth of 25'. The wall and dome roof of this tank are all "GUNITE." This is just one of scores of similar tanks designed and built by us.

We will be glad to discuss your tank needs with you and submit designs and estimates for your consideration.

Our method of pre-stressing the hoop rods in the wall and in the dome ring assures a bottle-tight and crack free reservoir.

Our 64-page bulletin C2400 describes this method of construction and also scores of other profitable uses of "GUNITE." A copy will be sent free upon request.

CEMENT GUN COMPANY
"GUNITE" CONTRACTORS
GENERAL OFFICES—ALLENTOWN, PENNA. U.S.A.
MANUFACTURERS OF THE CEMENT GUN

Literature & Catalogs

Hydrocrane Versatility

528

Bucyrus-Erie Company, Milwaukee, Wis., has just published a booklet titled **"Busy As A Bee."**

The two-color, 24-page booklet pictorially illustrates the machine's versatility by showing it doing everything from digging ditches to moving furniture through second story windows.

The more than 100 illustrations show the machine with its many attachments placing tanks and pipe; digging, trenching and back-filling; joisting and erecting; loading, unloading and stockpiling; and cleaning catchbasins, removing snow and stumps and cleaning up in quarries, mines and public streets.

Centrifugal Pump Instruction Booklets

529

Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has just released two instruction booklets covering the **Installation, Operation and Repair of Single-Stage, Single-Suction and Multi-Stage Centrifugal Pumps.**

The booklets include a description of such late developments as "Magic-Grip" couplings, universal joint couplings with "Magic-Grip" bushings, mechanical seals, etc. Section drawings are of a large size for easy reference.

The booklets recommend that regular inspection be followed and each carries a page on which the user can keep a maintenance record of his pump. Each booklet also has a handy reference table explaining how to locate trouble and listing possible causes and cures.

Standby Emergency Power

530

Electric Machinery Mfg. Co., Minneapolis, Minn., featured in their quarterly publication **"E-M Synchronizer"** an article on **Standby or Emergency power.**

Written by E. W. Kammerer, E-M Switchgear Engineer, this article deals with the requirements of standby power, the types of service available, and a detailed discussion of controls for automatic start-stop operation. It is also fully illustrated with diagrams and typical installation pictures.

DuPont Hydrofluosilic Acid

531

E. I. DuPont De Nemours & Co., Wilmington, Delaware, has just published a pamphlet on **DuPont Hydrofluosilicic Acid** (30%) for use as fluoridating agent in public water supplies.

The pamphlet describes the properties of the acid, which is a 30% aqueous solution, gives its advantages, uses and hazards in handling.

Centrifugal Blowers

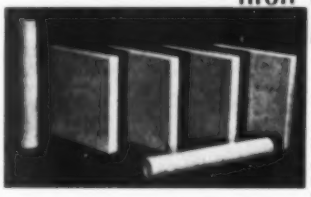
532

Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has published a bulletin featuring **Multi-Stage Type V Centrifugal Blowers.**

The bulletin discusses the construction features of the blowers for equivalent air pressures above 6.5 psig and inlet volumes above 1500 cfm.

Illustrations include a complete cross-section of a multi-stage Type V gas exhauster, photographs of components of multi-stage Type V blowers, of two-stage, three-stage and four-stage blowers with the tops

FILTROS HIGH PERMEABILITY AIR DIFFUSER PLATES



The trend to the use of higher permeability plates (40 to 80 perm.) throughout the Activated Sludge Process Field, finds FILTROS again in the forefront. The same qualities which have made FILTROS famous in the low permeability field are now available in these higher ratings as well. FILTROS round grain construction is a big factor in the long years of service these plates are giving in many outstanding plants throughout the country, such as:

Milwaukee, Wisc., (25 yrs.) — **Hagerstown, Md., (19 yrs.)**
Peoria, Ill., (20 yrs.) — **Phoenix, Ariz., (14 yrs.)**
Chicago North Side, (22 yrs.) — **Mamaroneck, N.Y. (23 yrs.)**

FILTROS long experience as America's pioneers in the manufacture of porous ceramic diffuser plates is at your service, and FILTROS engineers offer personal attention to your problems—whether you are planning new installations, or are having difficulties with your present system. Write for further information, literature, today. (Porous filter bottoms for water filtration and other uses are also available.)

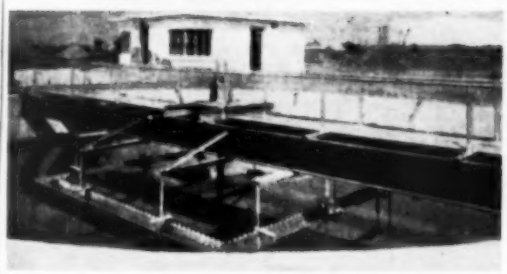
FILTROS

FILTROS, INC.

602 W. Commercial St. — **East Rochester, New York**

Serving the Activated Sludge Process Field with Porous Ceramic Air Diffusers since 1917

LAKESIDE Spiraflo CLARIFIERS



EMPLOY PERIPHERAL FEED AND CENTER COLLECTION IN COMBINATION WITH UPWARD FLOW . . .

Experience has shown that if certain design features are used with Spiraflo Clarifiers better operating results can be obtained. We will be glad to send you a copy of these features to assist you in your design upon request.

LAKESIDE ENGINEERING CORP.
222 WEST ADAMS STREET • CHICAGO, ILLINOIS

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

CUT COSTS

ON UNDERGROUND

PIPING JOBS

...with a GREENLEE PIPE PUSHER

Installing pipe underground is quick and simple this way. With a GREENLEE Hydraulic Pipe Pusher *one man* pushes pipe through the ground—under streets, railways, walks, lawns, floors. Saves time, cuts costs through elimination of extensive ditching as just a short trench accommodates the Pusher. No tearing up of pavement, lawns, floors . . . eliminates tunneling, back-filling, tamping, repaving. Cuts job time to a fraction. Pusher often pays for itself through timesavings on first job or two.

No. 700 GREENLEE PUSHER For 3- 4 to 4-inch pipe. Six speeds — 5,600 to 40,000 lbs. pushing pressure.

No. 705 GREENLEE PUSHER For pipe larger than 4-inch, concrete sewer pipe, large drainage ducts. Six speeds — 25,000 to 150,000 lbs. pushing pressure.

POWER PUMP For both sizes of GREENLEE Pushers. Pushes pipe at rate of two feet per minute.

GREENLEE

Get facts on timesaving Greenlee tools now. Write Greenlee Tool Co., Division of Greenlee Bros. & Co., 2246 Columbia Avenue, Rockford, Illinois, U. S. A.

of their casings removed, and of typical installations in a variety of industries.

Backfiller-Tamper-Side Crane

533

Cleveland Trencher Co., Cleveland, Ohio, has just published a four-page, two-color bulletin on the **Cleveland Model 80 Backfiller - Tamper - Side Crane.**

The bulletin uses text as well as action photographs to good advantage in depicting and describing the varied operations performed by the 80. Complete specifications and dimension data are clearly presented.

Product Selector by Dresser

534

Dresser Manufacturing Division, Dresser Industries, Inc., Bradford, Pa., offers a new, four-color laminated wall chart showing "the right product for every piping need."

Called the **Dresser Handy Product Selector,** it answers at a glance questions in regard to couplings, clamps, fittings and repair devices for pipe of every kind and size. The chart is available in two sizes—22x34 inches, which has a tinned top and bottom for convenience in hanging, and a smaller 10½x16-inch chart.

Composite Instrument Catalog

535

Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Philadelphia, Pa., has just published a **Composite Catalog No. 5000,** that consists of 28 pages describing the principal instruments, control devices and related components manufactured by the company. Photographs of each piece of equipment accompany the text matter.

Specifications of approximately 100 measuring and control instruments, and valves are outlined. Included also are several new designs including the Differential Controller and Tel-O-Set Controller family.

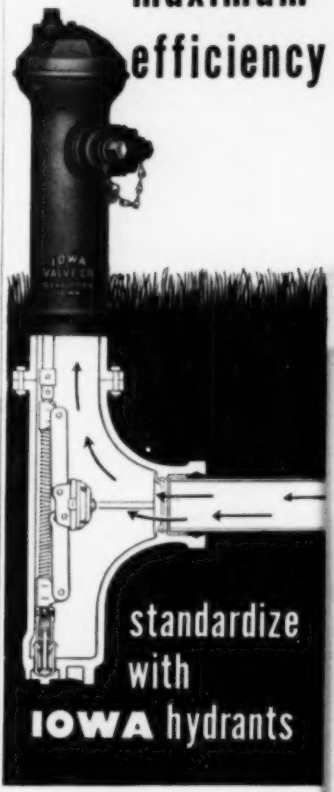
Controlled Air Pressure System

536

Infilco Inc., Tucson, Ariz., has published a bulletin on the **C.-A.-P. System.**

The bulletin describes the C.-A.-P. (Controlled Air Pressure) System as a system that provides an instantaneous pneumatic control for operating Loss of Head and Rate of Flow Gages, Level Gages, Rate of Flow

for maximum efficiency



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Cut-away drawings are provided throughout the bulletin to illustrate the operation of the system and methods of applying it to various systems.

Automatic Cushioned Water Valves

537

Golden Anderson Valve Specialty Company, Pittsburgh, Pa., has just published an 8-page, 2-color bulletin describing the features of Golden Anderson's **Cushioned Automatic Water and Steam Valves.**

Featured in this catalog are float valves, altitude valves, check valves, Solenoid-operated valves, reducing valves, relief valves and non-return valves.

Graphical Data for Designing Grit Channels

538

American Well Works, Aurora, Ill., has just published an **Addendum No. 1** that enlarges upon the information contained in the Technical Supplement, on **American Camp Grit Chambers.**

The graphical data shown in the supplement provides a useful tool for designing a complete grit channel in a matter of minutes by furnishing the Engineer and Operator with concise and accurate design data for grit removal. The basic equations of grit channel design have been plotted over the entire range of applications, so that for any given set of conditions all of the required pertinent information can be obtained from the eight graphs shown in the supplement.

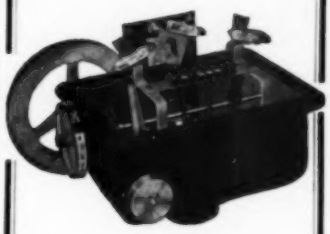
Loss-In-Weight Feeder

539

Omega Machine Co., Providence, R.I., has announced a new bulletin on **Loss-in-Weight, Gravimetric Feeders for Dry Materials.**

The 4-page bulletin describes the Loss-in-Weight Feeder and discusses its operation, feeding range, vibratory feeding mechanism, synchronous motor feed rate control, and hopper mounted on a specially built Omega pipe lever suspension scale. Accesories described include a chart

ROTO-TROL



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recorder, hopper agitators and dissolving chamber.

The bulletin lists the following features for these Feeders: High Accuracy, Wide Range, Large Scale Beam Capacity, Automatic Sentinel Alarm System, Totalizer-Register, Time-Saving Design and Modern Appearance.

Water Conditioning Data Book

540

Permutit Company, New York, N.Y., has just published a handy 5x7-inch enlarged edition of their **Permutit Water Conditioning Data Book.** This book supersedes an earlier volume produced in 1949. Brought up-to-date and completely revised, it presents a compilation of 77 tables, all valuable to the engineer.

A few of the subjects covered are: Hydraulics, Impurities in Water, Chemical Conversions, Saturated Steam, Boiler Feedwater Makeup Requirements, Chemicals Used in Water Treatment, Alkalinity Relationships, Specific Gravities, and Chemical Reactions.

Sludge Pumps

541

Ralph B. Carter Co., Hackensack, N.J., has available a 16-page, 2-color bulletin on **Carter Plunger Sludge Pumps.**

The bulletin describes and gives engineering data and specifications on the three basic models of plunger-type sludge pumps: The Balto; Standard; and Heavy-Duty. Amply illustrated with photographs and drawings it discusses the different drives, motors and design features. A pump selection chart and motor horse-power selection chart complete the bulletin.

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TEFC Motor Bulletin

542

Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has just released a bulletin giving construction features and details of **Allis-Chalmers Totally-Enclosed, Fan-Cooled Motors** with tube-type, air-to-air heat exchangers in ratings from 40 hp at 600 rpm through 800 hp at 3600 rpm.

The bulletin points out that the motors are available in standard and explosion-proof designs. The former are for applications without explosion hazards but requiring protection of the windings from dust, dirt, acid fumes, etc.

Flow Measurements Through Parshall Flumes and Weirs

543

Minneapolis-Honeywell Regulator Co., Brown Instruments Division, Philadelphia, Pa., has just published an instrumentation data sheet on **Accurate Measurement of Flow Through Parshall Flumes and Weirs.**

The data sheet describes the operation of Brown float actuated, evenly divided flow meters which are especially applicable where Parshall flumes and weirs are used to create a fluid head. The data given comprehensively covers various system arrangements, principle of operation, specifications of the instrument and other pertinent data.

Pulsafeeder for Controlled Volume Pumping

544

Lapp Insulator Co., Inc., Process Equipment Division, Leroy, N.Y., has just published a 24-page two-color bulletin describing the **Lapp Pulsafeeder.**

The feature of no stuffing box is stressed throughout the bulletin, and it is noted that Pulsafeeder, although basically a pump, will do the work of a chemical feeder, a meter, an instrument, a filling machine, a proportioner and a sampler.

The bulletin also goes into considerable detail on special liquid-handling assemblies which cover the completely non-metallic construction of Lapp Chemical Porcelain and Fluoro-plastics, a double diaphragm head for liquid chlorine and other hazardous liquids, a completely isolated pumping head, a head for gas compression and an all welded assembly without gaskets.

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

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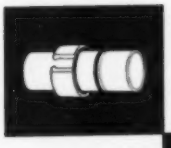
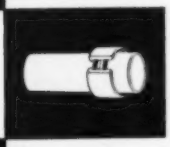


◀ **Start of assembly.** Two rubber rings and a Transite sleeve (cut away to show position of the rings) are placed on one of the two pipe ends to be joined.



▶ **Final position.** Sleeve centered over both pipe ends, with the rubber rings tightly compressed between sleeve and pipe.

◀ **Checking joint** for proper assembly. This is done with a simple gauge immediately after the joint is made . . . *before backfilling.*

*Transite is a registered Johns-Manville trade mark

The photograph above shows the total amount of infiltration—through manholes as well as pipe—in a recently installed sewer system consisting of 5 miles of 6", 8", 12" and 18" diameter Transite Sewer Pipe. So little ground water entered the system that the only practical way it could be measured was by means of a 3" pipe inserted in the Parshall flume as shown here!

Here is visual proof that Transite Sewer Pipe with its Ring-Tite Joint cuts ground water infiltration to a minimum—in this case less than 3.4% of the specified allowable of 600 gallons per inch of pipe diameter, per mile, per day.

The Ring-Tite Joint, standard on all sizes of Transite Sewer Pipe, has other important practical advantages, too. Actually a factory-made joint, it can be assembled in a fraction of the time required for making ordinary sewer pipe joints. No jointing compounds are used—just a simple assembly operation with a mechanical coupling puller does the job. And you can check each joint for proper assembly as soon as it is made—*and backfill immediately!*

Transite Sewer Pipe may also help you save in other ways. Its long 13-foot lengths mean *fewer* joints to make—thus further reducing installation expense. And its high flow capacity (Manning's n = .010) often permits flatter grades and shallower trenches—particularly important where pipe is laid at or below the ground water line or where rock excavation is required.

For more facts about this asbestos-cement pipe and how it can save money for you, write for Folder TR-103A. Address Johns-Manville, Box 60, New York 16, N.Y.

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B

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*Builders-Providence, Inc. — 102A
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C

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*Chicago Bridge & Iron Co. — 3A
*Chicago Pump Company — 75A
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D

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E

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F

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G

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H

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I

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J

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K

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L

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M

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N

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O

*Omega Machine Co. — 23A

P

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Payne Dean & Company — 112A
*Permutit Company — 25A
Philadelphia Quartz Co. — 105A
Phipps & Bird, Inc. — 111A
*Pittsburgh-Des Moines Steel Co. — 11A
Pollard Co., Inc., Jos. G. — 111A
Price Brothers Company — 8A

R

Ridge Tool Company — 80A
Roberts Filter Mfg. Co. — 112A
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S

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T

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U

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*U. S. Pipe & Foundry Co. — 9A
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W

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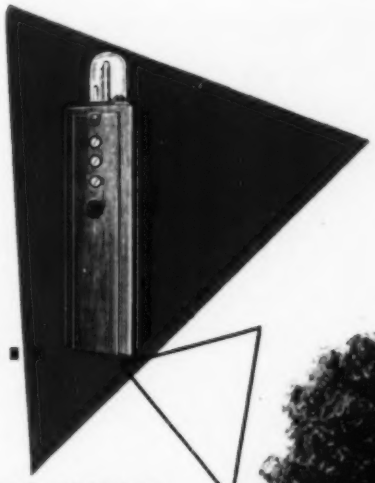

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